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CONTENTS OF VOLUME XVII.

NUMBER 65.

NUMBER 66.

vi   CONTENTS

CONTENTS

GENERAL INDEX TO VOLUME XVII.

SUPPLEMENT : ATLAS OF PATHOLOGICAL ANATOMY.

FASCICULUS V : DISEASES OF THE GALL-BLADDER AND BILE-DUCTS.
INFLAMMATION OF BONE.

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EPOCH-MAKING BOOKS IN BRITISH SURGERY.

By Sir D'ARCY POWER, K.B.E., London.

IX. THE WORKS OF PERCIVALL POTT.

THE writings of Percivall Pott exercised a very great influence upon surgery during the last half of the eighteenth century. They were read both at home and abroad, and his name is better known on the Continent than that of any other English surgeon except Lister—better even than that of John Hunter—by the rank and file who have no knowledge of the history of surgery. His recognition in England is due to several causes. He was a popular lecturer in London when a desire was arising for improved instruction in surgery. His lectures were open to all on payment of a small fee and were attended by large numbers. He often published his observations in the form of pamphlets at a cost of one shilling and sixpence, instead of in the heavy and expensive volumes of his predecessors. He wrote well and clearly from his own experience. His pamphlets, therefore, were interesting and could be read with pleasure and profit by those who were just awakening to a knowledge of their own ignorance. Mentally he was not much in advance of his time, for scientific surgery had not yet come into being, and he was essentially a clinical surgeon, who observed what he saw and taught his pupils to follow his example. For the most part he stood on the old ways and followed the old lines of treatment, but he straightened out and made plain the paths so that his followers walked along them more easily and were able to go further.

Pott, as is well known, did not begin to write until he was forty-two years old, and only then because he had broken his leg and wanted to employ his active mind during the tedium of convalescence. He then planned and partly executed his "Treatise on Ruptures," which was published in 1756 and was completed by his "Rupture in Infants" which appeared in 1765.

The opening sentences of the "Treatise on Ruptures" is still applicable, and the warning is as necessary now as when Pott wrote. He says: "The generality of mankind look upon a rupture as an imperfection in their form, as a disease which impairs their strength and lessens their generative faculty; which apprehensions, though absolutely groundless, are so firmly rooted in

the majority of those who are afflicted with the disorder as to make them not a little miserable.   They who lie in wait to avail themselves of the weaknesses of the infirm and fearful, are well acquainted with these fears, and very lucrative use do they make of them ; they well know that a man who regards his disorder as an imperfection in his form or as a cause of any debility, more particularly a venereal one, will be very unwilling to have it known, and as glad to get rid of it at any expence or trouble ; by this means impostors are furnished with opportunities of subjecting the ignorant and credulous to tedious confinements, painful applications and even hazardous operations ; and of defrauding the timorous and bashful of large sums of money for imaginary diseases and pretended cures.

"A rupture is a disease which, if judiciously and honestly treated from the first, can never be productive of much profit to a surgeon ; it requires very little attendance and neither external application nor internal medicine ; though the reduction of the gut and the application of a proper bandage are necessary, yet this is, in general, so soon and so easily accomplished that it must be obvious no great emolument can from thence be derived." This was written at a time when the family practitioner was paid for the plaster he applied and the bottles of physic he prescribed and never for the time taken or the advice given.   The treatise is thoroughly practical, and did much to standardize the treatment both of reducible and strangulated hernia.   Of reducible hernia he says : "Let the cause [course] of it be what it may, as it can never be absolutely foreseen it should never be trusted ; the sooner a rupture is reduced, the sooner a patient is out of danger."   Of strangulated hernia he advises : "If I might presume to give my opinion on the subject, I should say, that the operation ought always to be performed as soon as possible after it appears that all rational attempts, by large and free bleeding, the warm bath, glysters &c. are found to be ineffectual ; or that the symptoms rather increase than decrease, while such means are made use of, and that the handling necessary for reduction becomes more and more painful."

The most important contribution to surgery made by Pott is "Some few Remarks upon Fractures and Dislocations", which he published in 1768. This pamphlet was written to abolish the use of instruments which had been employed to extend and counter-extend the fractured limb and to replace the old methods by keeping the muscles in a state of relaxation.   It effected its purpose, and for several generations Pott's treatment of fractures was generally employed throughout England.   The paper, too, gives a detailed account of that form of fracture and displacement at the ankle to which Pott's name is now universally attached.   It was written some time after he had himself suffered from a similar injury, but he writes of it quite impersonally and makes no reference to his own experience.   He points out that if the fracture is treated in the usual way by extension there is difficulty in reduction, the foot is distorted, and if it be pulled outward and upward the deformity which always accompanies the accident is produced ; but "if the position of the limb be changed ; if by laying it on its outside, with the knee moderately bent the muscles forming the calf of the leg and those which pass behind the fibula and under the os calcis are all put into a state of relaxation and non-resistance, all this difficulty and trouble do in general

vanish immediately; the foot may be easily placed right, the joint reduced and by maintaining the same disposition of the limb everything will in general succeed very happily, as I have many times experienced."
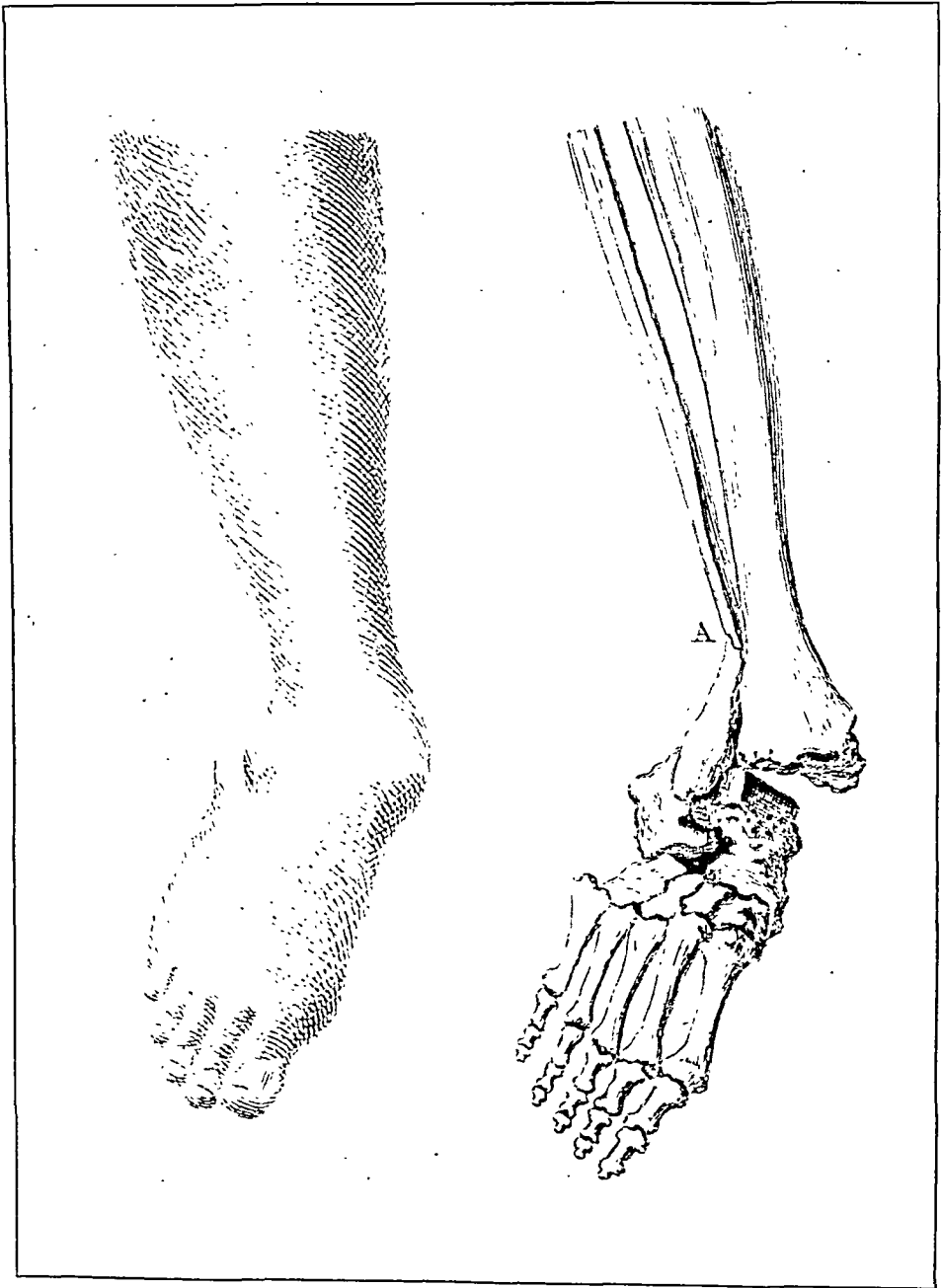
The original drawing by which Percivall Pott illustrated his description is reproduced here from the first volume of his collected works published in 1779. He says: "When by leaping or jumping the fibula breaks in the

weak part already mentioned, that is within two or three inches of its lower extremity. When this happens, the inferior fractured end of the fibula falls inward toward the tibia, that extremity of the bone which forms the outer ancle is turned somewhat outward and upward and the tibia having lost its proper support and not being of itself capable of steadily preserving its true perpendicular bearing, is forced off from the astragalus inwards by which means the weak bursal, or common ligament of the joint is violently stretched, if not torn and the strong ones which fasten the tibia to the astragalus and os calcis, are always lacerated, thus producing at the same time a perfect fracture and a partial dislocation, to which is sometimes added a wound in the integument, made by the bone at the inner ankle. When this accident is accompanied as it sometimes is by a wound of the integuments of the inner ankle and that made by the protrusion of the bone, it not infrequently ends in a fatal gangrene unless prevented by timely amputation though I have several times seen it do very well without. But in its most simple state, unaccompanied with any wound, it is extremely troublesome to put to rights, still more so to keep it in order and unless managed with address and skill, is very frequently productive both of lameness and deformity ever afterward."

Certainly the best known of Pott's writings was that which he entitled, " Remarks on that kind of Palsy of the Lower Limbs which is frequently found to accompany a Curvature of the Spine and is supposed to be caused by it." There are 83 pages for one shilling and sixpence, and it was published in 1779. In the same year it was translated into Dutch and into French at Brussels ; in 1783 it was again translated into French at Paris. The influence and importance of the tract may be estimated by the fact that the particular form of disease it described was for many years known everywhere as " La Maladie du Pott ", though it is now called tuberculous disease of the spine. Pott gives a masterly description of the signs and symptoms, but he did not, of course, know its cause, nor was his treatment based on any rational method. One of the specimens illustrating his paper is still preserved in the Museum of St. Bartholomew's Hospital, where it is numbered 1097.

The most interesting of Pott's tracts for the modern reader is without doubt his " Observations on the Nature and Consequences of those Injuries to which the Head is Liable from External Violence." The essay is full of well-told cases illustrating the state of London at the time it was written in 1768. Here are some examples : " A poor fellow crossing Tower Hill, got, before he was aware of it, into a mob, that was endeavouring to rescue a sailor from a press-gang. The man was knocked down. When the crowd dispersed he was found senseless and in that state was brought to St. Bartholomew's Hospital, where he was immediately let blood and put to bed. In an hour or two he was so recovered as to be able to give the preceding account.

" When Mr. Nourse [to whom Percivall Pott was assistant surgeon], whose week it was for accidents saw him the next day, the man appeared to be perfectly well, nor did any mark of violence appear on his head, except one small bruise, and that so slight, that it might with more probability be attributed to the fall than to the blow. However as he was positive that he had been knocked down by a very smart blow from a heavy weapon, and

as he had certainly been deprived of sense a considerable time thereby, Mr. Nourse bled him again and ordered him to be kept in bed and to a very low diet. At the end of three days the man found himself so well as to leave the hospital and go to work. On the twelfth day from that of the accident he came to my surgery and complained of being much out of order, said that his head was very uneasy ; that he was hot, thirsty, got little or no sleep and was, at times, so faint that he could not pursue his labour. He looked ill, assured me that he had lived very soberly from the time of his leaving the hospital and that he had been in his present state for three days past. I took him into the house [i.e., the hospital] again, bled him, ordered him a glyster immediately and that he should be kept in bed.

" Next day (13th) he was in much the same state as the preceding ; he had passed a restless night, had dozed now and then but awoke with much disturbance. He had a hot skin and a flushed countenance mixed with a light yellow tint. He complained of general pain and tightness all over his head, but neither to the sight nor to the touch was there any appearance or sensation whereon to build a probable supposition of particular mischief. He was again, by the physician's order, let blood and directed to take the sal absinthii mixture with a few grains of rhubarb in it every six hours. He passed the ensuing night in a disturbed manner and the next day (the 14th) was apparently worse ; his skin was hotter, his pulse quicker and his pain more acute. He also now thought that one part of his head was tender to the touch and said he was sure that was the part that received the blow. This place I examined. The scalp did seem to be rather fuller than natural but by no means sufficiently so to enable me to form any judgement by. Towards the close of this day he had a slight shivering, was sick and vomited and passed the following night without any sleep at all ; talking sometimes incoherently but still capable of giving a rational answer to any question which engaged his attention. On the 15th day the tumour of the scalp was more apparent, but yet seemed to contain little or no fluid and was about the breadth of a crown piece. I would have removed that portion of scalp ; but while I was intending it, the poor man had a very severe rigor, which disordered him so much, that he begged to be let alone for the present. That afternoon he had two more shiverings, passed very ill the following night and next morning was delirious. The tumour now was more risen, contained palpably a fluid but was by no means tense. I took away the whole piece by a circular incision, gave discharge to a thin brown sanies and found the cranium perfectly naked, altered considerably in colour from that of a natural healthy one, but without fissure, fracture or other evil. That whole night and next day he was delirious, his skin burning hot ; he had frequent spasms which shook his whole frame and the next night (the 17th) he died.

" The whole scalp, except round the edge of the incision, was in a natural state ; the pericranium in every other part, except the tumid one, adhered to the bone ; and neither inflammation nor tumour of any kind all over the rest of the head. Under that part of the skull from which the pericranium had been detached and from which the scalp had been removed a very considerable collection of matter was found lying between the dura mater and cranium but no appearance of disease anywhere else."

Life was leisurely in those days, for in another case " A young fellow of about twenty years was thrown from an unruly horse against one of the rails in Smithfield. The blow was great ; he lay senseless for above an hour and in that state was brought into St. Bartholomew's Hospital." In like manner " A girl about fifteen years old crossing Smithfield on a market day was tossed by an ox, and fell with her head on the flat stones within the posts. As her dress was mean and nobody knew anything about her she was brought senseless into the hospital."

Domestic quarrels, then as now, caused patients to be admitted to the hospital. Thus " A woman came to my house complaining that her husband had kicked her downstairs and had broke her skull. I took her into the hospital where she was taken all possible care of, but she became first paralytic and then comatose and so died. There was a large lump of firmly coagulated blood near the origin of the medulla oblongata." " A man in the neighbourhood of St. Giles's had a quarrel with his wife in which he struck her over the head with a mop-stick. The blow was a smart one but as it fetched neither blood nor brought her to the ground it only finished the dispute and no further notice was taken of it. The woman followed her business, which was that of crying greens about the street and lived (to use her own words) sometimes drunk and sometimes sober for a week. On the eighth day from that of the blow she found herself so ill that she applied to the hospital for admission and was taken in as a physician's patient for a fever. The doctor wrote for her and the day after this (the tenth from the accident) the sister of the ward in cutting off the patient's hair which was full of vermin, discovered a swelling which she desired me to look at. It was flattish, about the breadth of a hand and lay immediately across the sagittal suture." She died on the sixteenth day from that of the accident, and upon opening the head the dura mater was found covered with matter.

Two female inhabitants of St. Giles's got drunk together and quarrelled. One of them threw a stool at the other and knocked her down. The edge of the stool cut through the scalp and broke the left parietal bone. She was trephined first on one side of her head and then on the other and died on the twenty-third day. In another case, " A watchman, whose stand was in Whitechapel, got into a scuffle with some drunken sailors and received several wounds and blows on his head from some of which he lost so much blood that he was the next day brought into St. Bartholomew's Hospital in a very weak, low state. As he had already sustained great loss of blood and was more than sixty years old I made use of no farther evacuation but dressed his head superficially and directed that he should be kept in bed. At the end of about a week when the general tumefaction was nearly gone and all the wounds in a healing state the man transgressed the rules of the hospital by staying out all night and was discharged. On the fifteenth day from that of the accident he came to me complaining of head-ache, giddiness, sickness, failure of strength, loss of appetite and want of sleep. I took him into the house again, trephined him in three places being satisfied that he had no other chance for life and was luckily disappointed in my apprehension as the bad symptoms gradually left him and the man got perfectly well."

CONGENITAL DIVERTICULA OF THE INTESTINE :

WITH THE REPORT OF A CASE EXHIBITING HETEROTOPIA.

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WITH A NOTE ON ITS PATHOLOGY BY CUTHBERT DUKES,

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THE following case of congenital diverticulum of the intestine presents features so unusual that no excuse is given for recording it in detail. Except for the omission of a certain amount of irrelevant material, the case history given below is practically a verbatim report of the patient's mother, and, in view of the remarkable nature of the diverticulum revealed after removal by operation, merits the closest attention.

CASE HISTORY.

C. C., a male and only child, was born in 1909 to healthy parents. Instruments were used during delivery, and at birth the child weighed 8 lb. He was bottle-fed. From the earliest days the child was subject to frequent attacks of crying, as if in severe pain, and on this account was regarded by both parents and doctor as a 'very sensitive child'.

At 4 months, after a violent screaming attack, there was a profuse hæmorrhage from the bowel, and for some time afterwards the motions were loose, and large clots of blood were passed. From this time onwards attacks of melæna and diarrhœa were of frequent occurrence. On many occasions so much blood was lost, and the child was left so weak after the attacks, that the parents despaired of his life. At 6 years the child contracted pneumonia, and for the remainder of his childhood was subject to frequent bouts of asthma and bronchitis.

When 9 years old, and after three years of freedom, the abdominal symptoms returned, and consisted of attacks of acute pain and vomiting, occasionally accompanied by diarrhœa and melæna. At 14 years the abdominal pain was practically constant. It came on about three-quarters of an hour after food was taken, but sometimes occurred independently of food. Great care was necessary with diet, which consisted almost entirely of milk foods. These attacks of pain were of daily occurrence during the months preceding admission to hospital, and were accompanied by vomiting and the passage of foul stools. The attacks were always followed by great prostration.

The final attack which led to admission into hospital commenced on June 2, 1926, and was of greater severity than all previous ones. The pain was so severe that the patient became delirious, and frequently violent.

Morphia was given by the doctor in full doses. Nothing swallowed could be retained, and there was severe diarrhœa. This attack lasted four days, at the end of which the patient was admitted into King's College Hospital. The pain subsided on the way to hospital, so that it was difficult to give full credit to the history related by the mother.

The patient was a pale and delicate-looking boy of 16, but of average size and intelligence. On examination there was a generalized increased resistance of the abdomen, and a marked aversion to being palpated. Otherwise there were no physical signs. The patient was able to eat a reasonably full diet without much discomfort, though he occasionally had 'rumbling pains'.

In view of the history, a provisional diagnosis of polyp of the small intestine was made, and preparations for an X-ray examination of the alimentary tract were begun. The diagnosis completely failed to satisfy the parents. It had been suggested many times before, and was regarded by them as no more likely than any other of the diagnoses which had accumulated during the sixteen years of illness. It is a matter for comment that the child had so long escaped an exploratory laparotomy.

A few days after admission there was a sudden and dramatic change in the condition of the patient. The abdominal pain returned. It was first centred round the umbilicus, and later became generalized. There was frequent and violent vomiting, and the pain was so severe that the patient became delirious and difficult to keep abed. The abdomen was distended, extremely tender, and as hard as a board. After a few hours the pain appeared to reach a climax, and then suddenly ceased, leaving the patient in a state of collapse. The pulse was 120, the respirations 30, and the temperature 97·2°. The abdomen was more distended, but much less tender, and easier to examine. The liver dullness was unchanged, but there was shifting dullness in the flanks. It was evident that perforation of the gut at some level had occurred, and immediate laparotomy was performed.

OPERATION.

The operation was performed by Mr. Arthur Edmunds. A left paramedian incision was made. On opening the peritoneum a large quantity of dark fluid escaped, which was at first thought to be bile. The gall-bladder was normal. On exposing the lower abdomen the cause of the condition was soon apparent. Standing out from the small intestine was a black pear-like structure, which proved to be the blind end of a diverticulum. The black appearance was due in part to the congestion caused by a partial twist of the diverticulum as it left the mesentery. Subsequent examination showed that it was also due to the fact that the diverticulum was filled with altered blood. At a distance of three inches from the blind end there was a small perforation. The attached end of the diverticulum ran for a long distance into the mesentery, and was ultimately lost to view.

The free end of the diverticulum was dissected off from the mesentery, to which it had contracted adhesions, and followed down to the point at which it emerged from between the mesenteric leaves. It was extremely difficult

to find out where the diverticulum opened into the bowel, and a long probe inserted through the perforation failed to demonstrate this. At some distance above the point at which the diverticulum left the mesentery, the bowel was clamped and divided; but two lumina were found, of equal calibre, like a double-barrelled gun. A point still further along the bowel was taken, and the latter again clamped and divided, and this time a single lumen was found. The intestine was also clamped and divided at a point below that at which the diverticulum left the mesentery, and the diverticulum and associated portion of intestine were removed. Continuity was restored by an end-to-end anastomosis, and the abdomen closed with drainage.
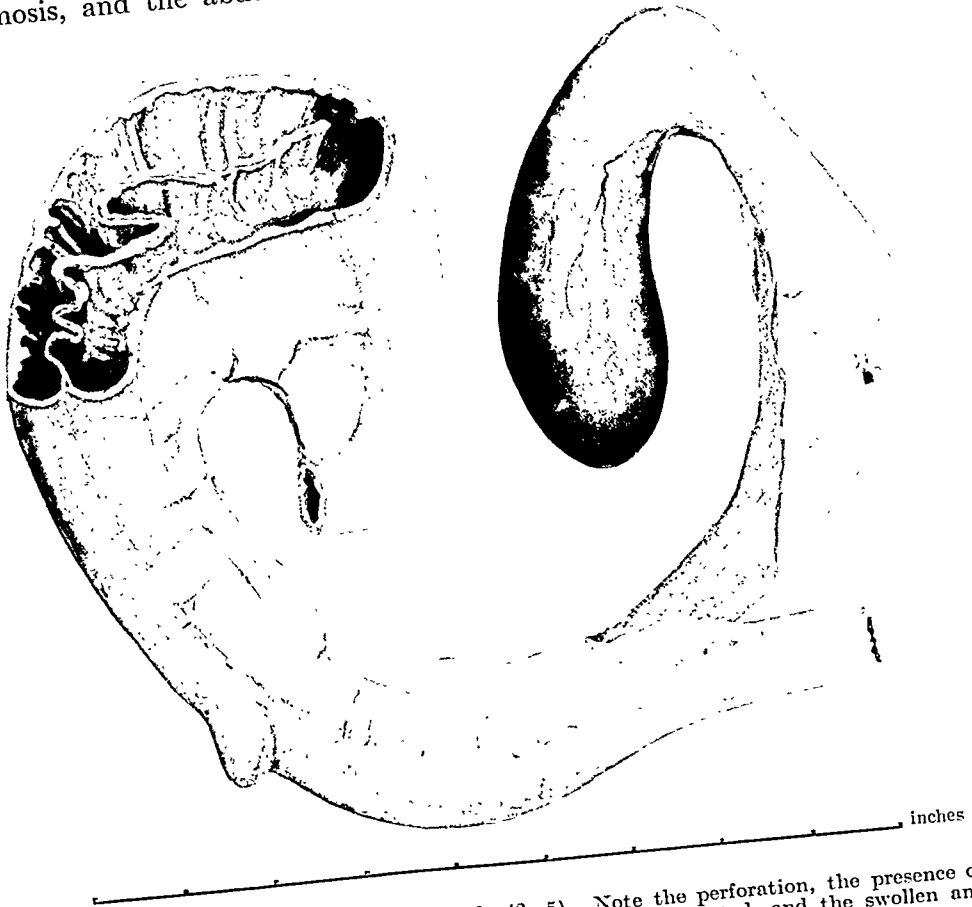
FIG. 1.—The specimen drawn to scale (2 : 5). Note the perforation, the presence of a typical Meckel's diverticulum on the segment of bowel resected, and the swollen and congested free end of the diverticulum.

During the operation the patient's condition gave considerable anxiety, and intravenous saline and injections of camphor were given. There was great improvement towards the end of the operation. The bowels were opened with an enema on the third day, and, apart from a rather alarming attack of vomiting on the third day, convalescence was rapid and uneventful. The patient remains well, and there has been no recurrence of pain or of any other of the old symptoms.

DESCRIPTION OF THE SPECIMEN.

The diverticulum is $28\frac{1}{2}$ in. long. For the first 17 in. it runs between the leaves of the mesentery along the antimesenteric border of the intestine. For the remainder of its course the diverticulum is free (*Figs.* 1, 2). The part which lies within the mesentery is of exactly the same calibre as the gut, except at its commencement, where there is a pouch-like dilatation. At the point at which the diverticulum leaves the mesentery there is a narrowing, and a little distance further a second narrowing, after which the diverticulum abruptly alters its course and terminates in a rounded bulbous extremity.
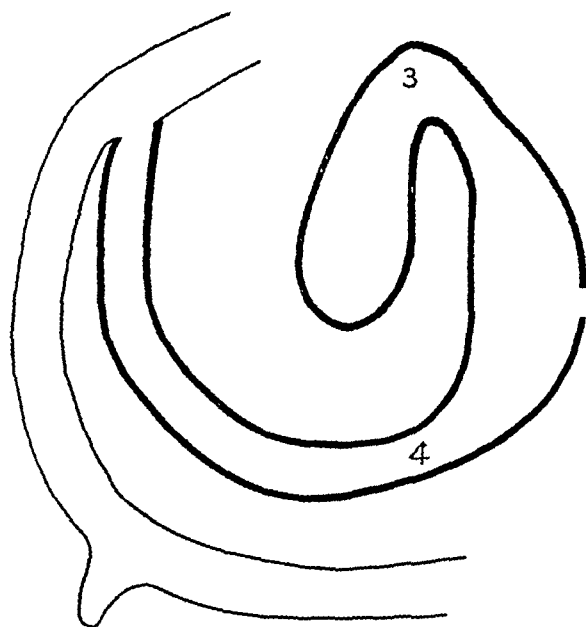
FIG. 2.—Line drawing of the specimen. The numbers 3 and 4 indicate the places from which the sections illustrated in *Figs.* 3 and 4 were taken. The gap in the diverticulum indicates the position of the perforation.

The mucous membrane lining the intramesenteric part of the diverticulum looks normal to the naked eye. In the free portion the mucosa is markedly thickened, and raised to form small polypoid masses which increase in size and definition as the distal end is reached (*Fig.* 3). Three inches distal to the point at which the diverticulum leaves the mesentery there is a small perforation. This corresponds to an oval ulcer on the mucous surface, measuring three-quarters of an inch in its long axis. The ulcer has a very indurated margin, and the terraced edge is typical of chronic peptic ulceration.

The muscle and submucous coats also show considerable thickening towards the free end of the diverticulum.

FIG. 3.—Low-power view of one of the polypoid masses within the lumen of the diverticulum. The magnification is insufficient to bring out the full contrast between superficial and deep epithelium, but shows the increased thickness of the mucous membrane. Section through 3 in *Fig.* 2. (× 8.)

The septum between the lumina of the intestine and the diverticulum commences as a thin membrane. It increases in thickness, and, at the point

where fusion ceases, consists of two complete intestinal walls except for the serous coat, the walls being separated by a thin layer of areolar tissue.

A typical Meckel's diverticulum is present on the portion of small intestine resected, and situated 7 in. from the commencement of the diverticulum (see Figs. 1, 2). It possesses a short mesentery, and opens into the gut midway between the mesenteric and antimesenteric borders.

There can be no doubt that the diverticulum, on account of its great size, its structure, which is identical with the intestine, and the fact that it gave rise to symptoms in infancy, is of congenital origin. Microscopic sections were prepared at various points along its wall.

NOTE ON THE PATHOLOGY.

By Cuthbert Dukes.

In structure this diverticulum exactly resembles a segment of normal small intestine. The tissues which compose its walls are arranged in their natural order, and no abnormality is to be seen, either on naked-eye or on microscopical examination, in the serous coat, in the longitudinal or circular muscle, or in the submucosa. The mucous membrane of the diverticulum, however, is appreciably thicker than that of neighbouring small intestine; its contour also is more irregular, being heaped up in some regions and thinner elsewhere.

Microscopic examination shows the mucous membrane to include two different types of epithelium. The surface layer consists of columnar mucus-secreting cells and has the appearance of healthy small-intestine epithelium. This superficial stratum provides an almost uninterrupted lining to the diverticulum, and here and there dips down into the deeper stratum, but never encroaches beyond the muscularis mucosæ. Lying beneath this single band of intestinal epithelium is a closely packed mass of glandular epithelium, the cells of which present a striking contrast to the superficial layer. These deeper wedge-shaped cells with their round nuclei and granular protoplasm do not secrete mucus, and in their shape and arrangement exactly resemble the central or peptic glands of the gastric tubules (Fig. 4). Arranged at the periphery of many of these glands, between the central cells and basement membrane, are large ovoid deeply-staining cells with clear or faintly granular protoplasm, which in their size, shape, and position exactly resemble oxyntic cells. In fact the histological picture presented by the deeper stratum of the mucosa is a faithful representation of human gastric mucous membrane. At one end of the diverticulum the mucous membrane is ulcerated, and here the cellular arrangement is similar to that of a gastric ulcer.

Section through the Meckel's diverticulum shows it to be lined by normal small-intestine mucous membrane.

THE MORBID ANATOMY IN RELATION TO THE CLINICAL HISTORY.

The ulcer is undoubtedly a true peptic ulcer. Its morbid anatomy, and the type of mucosa in which it has occurred, establish this. The complications of the ulcer, moreover, are typically those to which a gastric ulcer is

prone—hæmorrhage and perforation. The high percentage of oxyntic cells in the diverticulum suggests that the mucous membrane of the latter was constantly bathed in highly acid fluid, which probably predisposed the diverticulum to ulceration.
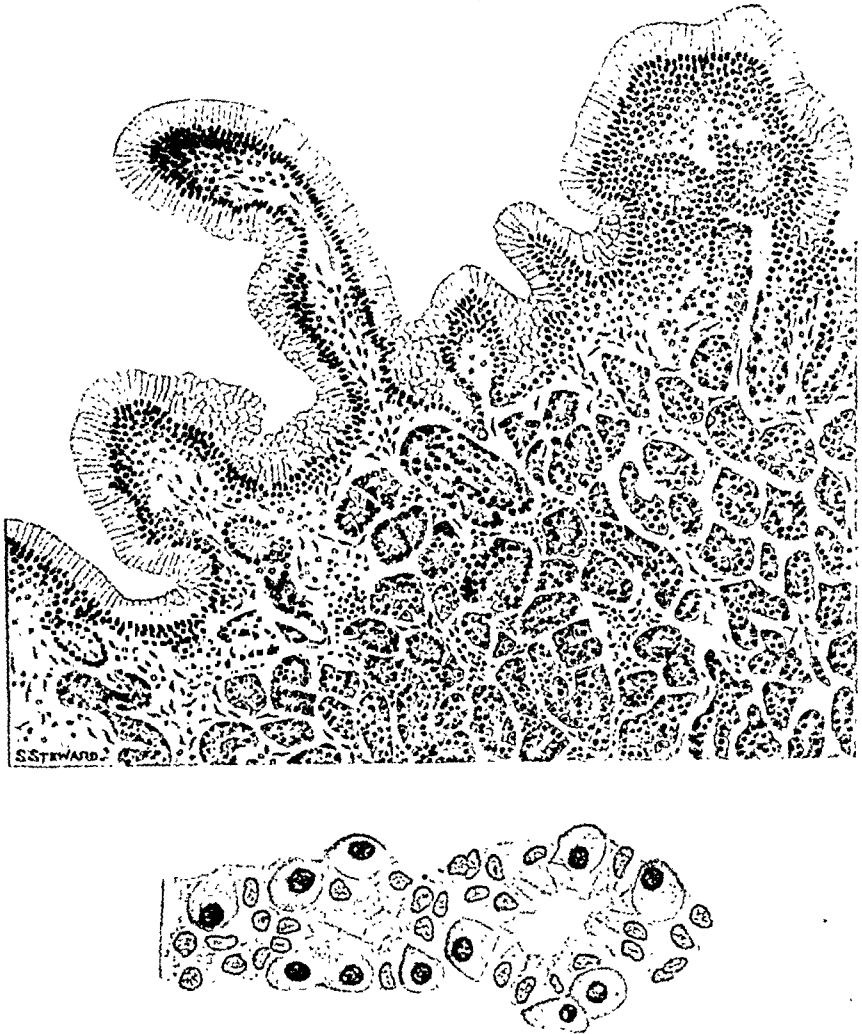
FIG. 4.—Section through the mucous membrane of the diverticulum (4 in *Fig. 2*). The superficial layer of epithelium consists of columnar mucus-secreting cells similar to the cells which line the small intestine. Beneath the superficial layer is a mass of glandular epithelium containing peptic and oxyntic cells similar to those of the gastric glands. The peripheral oxyntic cells are stained with Biebrich's scarlet. (Magnification of larger illustration = 120; of smaller = 450.)

Pain seems to have been a frequent symptom from the earliest days. The attacks may have been due in part to spasm of the wall of the diverticulum. The marked hypertrophy of the muscle coat is evidence that it was called upon to expel its contents against resistance, which was probably offered by the narrowing where the diverticulum left the mesentery. Later on, when

the child was about 14 the attacks of pain were typical of those of a gastric ulcer. They were prone to arise about three-quarters of an hour after food was taken, though occasionally they occurred apart from food. It was found necessary to keep the patient on a milk diet at this time. It seems very probable that the post-prandial pain was definitely related to the ulcer in the diverticulum. What actually produced the pain is a matter for conjecture. The ingestion of food may have caused a reflex secretion from the wall of the diverticulum, which irritated the sensitive ulcer. The fact that the diverticulum was probably always full of highly acid secretion makes this unlikely. It is more probable that the pain was muscular, and due to reflex contraction of the diverticulum following the passage of food through the pylorus. It is of interest to note that the ulcer, though some twenty feet distal to the stomach, caused pain so soon after food entered the stomach, and is striking evidence that the pain of gastric ulcer of the ordinary type is not due to the irritation of the ulcer by the food swallowed, or by increased secretion of hydrochloric acid, but is in all probability muscular.

The attacks of diarrhœa may have been due to the irritation of the lower ileum by the highly acid contents of the diverticulum. The vomiting, which in the later stages was so prominent a symptom, may have been reflex from the ulcer pain, or due to spasm of the diverticulum.

HETEROTOPIA AND ITS SIGNIFICANCE.

The mucous membrane of the diverticulum includes epithelium of both intestinal and gastric types. Such a heterotopia, or misplacement of epithelium, is not common in the small intestine, but is met with occasionally in congenital diverticula of the intestine. Taylor's[1] article on the heterotopias of the alimentary tract is a valuable survey of this interesting abnormality, and Dr. Dukes and I have nothing to add to his authoritative description from the pathological standpoint.

The great interest in the present case is that it illustrates the surgical importance of heterotopia, and brings the condition under the notice of the clinician. Taylor is inclined to belittle the clinical significance of heterotopia. In the present case it was undoubtedly responsible for a prolonged illness, and eventually originated an acute surgical condition. Judging from the vigorous appearance of the thick layer of gastric epithelium, the diverticulum must have been constantly full of gastric juice, thereby paving the way for ulceration, and thus an easily distinguishable sequence connects the three pathological conditions : (1) Congenital diverticulum ; (2) Gastric heterotopia ; (3) Ulceration.

Chronic ulceration in a Meckel's diverticulum is not excessively rare. Taylor[1] states that Humbert has recently collected six cases from the literature, and adds a personal one. Of these, six had repeated intestinal hæmorrhages, and no fewer than five went on to perforation. All were in boys.

Occasionally accessory pancreatic tissue, another example of heterotopia, is associated with diverticula, and may even be the cause of diverticulum formation (*see below*). Symptoms may be caused through strangulation of the intestine around bands attached to the accessory pancreatic tissue.

ETIOLOGY OF CONGENITAL DIVERTICULA OF THE INTESTINE.

The term ' congenital ' is restricted to diverticula present from birth, and identical in structure with the gut from which they open—that is, they have a serous coat, a double layer of muscle, a submucous coat, and a mucous membrane.

The great majority of congenital diverticula are Meckel's diverticula. The remainder form a small group, whose etiology is little understood, and it is to this group that attention is drawn. These diverticula differ from those of the Meckelian type in that, whereas Meckel's diverticula result from an arrest of normal development, the former arise as the result of abnormal development.

Diverticula belonging to this group are most common in the ileum, but are sometimes found in the jejunum, and very occasionally in the large intestine. I can find no case of proven congenital diverticulum of the duodenum in the literature, nor in any of the medical museums visited in London. Hedinger[2] describes a case of multiple diverticula of the vermiform appendix in a new-born male child. A large umbilical hernia was present in which was found a portion of the large intestine and the appendix. The proximal two-thirds of the appendix were normal in size, and had a normal opening into the cæcum. The distal third was small in comparison, and to its apex was attached an adhesion from the hernial sac. On this portion of the appendix there were several small elevations under the serosa, which proved on microscopic examination to be a number of hernial protrusions through the muscle coat. This case is unique, as far as I have been able to determine. The diverticula, being solely hernial protrusions of the mucosa, do not come within the bounds of the definition of congenital diverticula given above, and, though present at birth, it is improbable that they are congenital in the true sense of the word. The presence of the adhesion suggests the possibility that these are traction diverticula, produced at a comparatively late period of intra-uterine life.

The diverticula of this group vary in size and shape. Some are cystic in form, and communicate with the bowel through a narrow aperture. Others are short and tubular, and associated with the presence of accessory pancreatic tissue. Others, again, are of great length, as in the case described above. In *Keen's Surgery*[3] these diverticula are discussed under two heads, ancestral and inclusion diverticula. The former are described as conical, arising from the ileum, and are regarded as of an ancestral nature, analogous to the appendages found in rabbits and cats : this type probably belongs to those arising in connection with accessory pancreatic tissue. The latter (inclusion) diverticula are described as almond-sized, sometimes pedunculated and occurring on the free border of the gut, and are regarded as probably related to the vitelline duct. This group, presumably, corresponds with the cyst-like diverticula mentioned above. No reference to the giant type is made.

The following classification will therefore be adopted for description. It is based partly on cases examined personally, and partly on references in the literature : (1) *Cyst-like diverticula ;* (2) *Diverticula associated with the presence of accessory pancreatic tissue ;* (3) *Giant diverticula.*

1. CYST-LIKE DIVERTICULA.

In the Museum of St. Bartholomew's Hospital is a specimen (No. 1925 a 1) described as a congenital diverticulum of the jejunum. It was removed post mortem from an infant who died with signs of intestinal obstruction. The specimen consists of the stomach and a portion of the small intestine. Eleven inches from the pylorus is a large cyst-like structure situated between the leaves of the mesentery. It communicates with the lumen of the jejunum by two orifices of unequal size. The smaller orifice is about 2 mm. in diameter, and has a regular margin. The larger orifice has an irregular margin, which suggests the possibility of its being an artefact. At the level of the diverticulum the gut is narrowed, but is dilated above. Microscopically the wall of the diverticulum is indistinguishable from that of the bowel.

Considerable doubt exists as to the mode of origin of a diverticulum of this nature. Its shape suggests very clearly that it bears a relation to cysts of the intestinal wall. Tiedman[3] records a case of intestinal diverticulum in which the communication with the bowel would only admit a fine probe. Numerous cases of complete cyst are to be found in the literature. Hunter[4] describes a bilocular cyst related to the jejunal wall, identical in structure with the gut, but completely shut off. I have recently described a case of cyst of the cæcal wall,[5] and MacAuley[6] has collected nine cases from the literature, and added one occurring in his own practice, of cysts in the ileocæcal region.

These being the facts, it is probable that cyst-like diverticula and true cysts of the intestinal wall share a common etiology. It is difficult, however, to determine their exact relation. A diverticulum may result from a cyst by acquiring a secondary communication with the bowel. Conversely, a cyst may be formed from a diverticulum by the sealing off of the latter's communication with the bowel.

The work of Lewis and Thyng[7] is invariably mentioned in connection with the etiology of cysts and diverticula. These observers found pouch-like processes arising from the gut, and epithelial nodules occurring in the wall of the gut, in the majority of the early embryos of the rabbit, the pig, and man, which they examined. They conclude that diverticula may result from the persistence of such pouches, and that cysts may arise from degeneration of the epithelial nodules. These findings were confined to the small intestine, with the exception of one case in which a collection of pouches was found opening from the cæcum.

As far as I know, these striking observations have not been confirmed. Moreover, these pouches and nodules were found in the majority of specimens, and were usually multiple, whereas both congenital cysts and diverticula are, in practice, very rare and always single. Gfeller[8] regards the cysts as arising in connection with an unobliterated omphalo-meseraic duct, either by separation of a part of the intestinal *Anlage* or by germinal displacement. This is unquestionably the most likely hypothesis, and it would appear that the cyst-like diverticula referred to are formed from intestinal cysts by the acquisition of a secondary communication with the lumen of the bowel.

2. DIVERTICULA ASSOCIATED WITH THE PRESENCE OF ACCESSORY PANCREATIC TISSUE.

These diverticula do not form so well defined a group as the above, and there is little doubt that the majority of specimens described as such are examples of Meckel's diverticula containing pancreatic tissue, an occurrence which, as before mentioned, is not infrequent. Clogg[9] was the first to draw attention to the subject in this country, in recording the case described below.

The diverticula are similar to Meckel's in size, shape, and situation, and I should be content to consider them all as of Meckelian origin were it not for the case quoted by Nauwerck.[10] In this case two were present. One was situated 80 cm. above the ileocæcal valve, and in all respects resembled a Meckel's diverticulum. The second was situated 2 cm. above the valve, and at its apex was attached an accessory pancreas possessing a duct. It is a well-established truth, as we shall have occasion to state further on, that two diverticula of Meckel cannot be present in one intestine. It follows that the second diverticulum could not have been of Meckelian origin, and the case furnishes proof that diverticula of this group can and do occur independently of Meckel's diverticula. It is probable that these diverticula owe their presence to the accessory pancreas, possibly because of traction exerted by the latter upon the wall of the fœtal intestine.

Clogg shares the view that the majority of recorded cases are Meckel's diverticula. His case may have been either. It occurred in a boy of 12. Laparotomy was performed for acute intestinal obstruction, and a loop of ileum was found strangulated below a band of fibro-fatty material which ran between the right iliac fossa and the apex of a diverticulum. The latter and a portion of the band were removed : it measured ¾ in. in length, and its structure was identical with that of normal small intestine. To its apex was attached a nodule of pancreatic tissue, also measuring ¾ in. (in diameter). It had developed within the wall of the diverticulum, and possessed no duct. Clogg quoted seven other cases from the literature, including the case of Nauwerck.

3. GIANT DIVERTICULA.

In view of the case described, chief interest centres around diverticula of this type. Though the condition is of considerable rarity, two cases have been published of recent years which afford striking parallels with my case— one of the small intestine recorded by Moll,[11] and the other of the large intestine by Garnett Wright.[12]

Moll's example is of exceptional interest, for not only were the anatomical findings similar to the present case, but the condition gave rise to a clinical picture which is almost identical. The likeness was carried to completion in that the pre-operative diagnosis in both instances was the same—intestinal polyp. Moll's specimen was in a child 5 months old. Melæna had occurred two days after birth, and before the child was 2½ months old there had been two further severe attacks. At 5 months the infant was admitted into hospital for another severe attack of bleeding, and a diagnosis of intestinal polyp was then made, and laparotomy performed. At operation free fluid

was found in the peritoneal cavity, the mesenteric glands were enlarged, and the condition was regarded as probably tuberculous. Death occurred a few days later. At autopsy a diverticulum 33½ in. long was found, opening from the small intestine two feet above the ileocæcal valve. It appeared to be identical in structure with the small gut. At its origin from the ileum there were two chronic ulcers, which Moll regards as the source of the hæmorrhage during life.*

In Wright's case the diverticulum was found in a woman of 27, who had given a history of constipation for many years. The diverticulum arose from the sigmoid colon, and was 37 in. long. At the commencement the adjacent walls of the bowel and diverticulum were indistinguishable. Fusion ceased 3 in. from the distal end, which occupied a position behind the peritoneum. The diverticulum resembled the gut in structure. The longitudinal fibres were evenly divided between the bowel and the diverticulum in the following way. The tænia libera was present on the true bowel but not on the diverticulum ; the tænia mesenterica was present on the diverticulum but not on the bowel ; the tænia omentalis bifurcated, half remaining on the bowel wall, and half passing on to the diverticulum.

ORIGIN.

All three cases resemble a reduplication of the gut, and it seems probable that they share a common etiology. It is unlikely that any theory of origin that will not satisfy all three is correct.

Moll regarded his case as a giant Meckel's diverticulum. This view cannot gain acceptance on the analogy of the case I have described, for in the latter a typical Meckel was actually present on the segment of bowel resected with the diverticulum (*see Fig.* 1). Two diverticula of Meckel never occur in the same bowel. To quote Howell Evans,[13] ". . . there is only one possibility of origin for two diverticula of Meckel, and that is when the omphalo-meseraic duct has longitudinally bifurcated in association with a double small intestine."

In discussing the origin of Garnett Wright's case, Sir Arthur Keith[14] suggested that the diverticulum might have arisen by the development of a median septum within the lumen of the bowel at an early stage of embryonic life, and pointed out that the exact division of the longitudinal muscle fibres between the diverticulum and the true bowel supports this view. Sir Arthur Keith, who has very kindly discussed my own case with me, is not, however, convinced that this view of the origin of giant diverticula is correct. The theory is certainly open to criticism. There is no case on record of a median septum occurring in the bowel. The nearest approach to this that I have seen is Specimen 1222–1 General Pathology Section, R.C.S. Museum. This shows a portion of the small intestine of an ox, to one side of which is a long

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* Since this article was sent to press, Professor Stuart and Dr. Moll have prepared microscopic sections from the wall of the latter's case. It is of great interest that the appearance of the mucous membrane in this case is identical with that of the case I have described, i.e., gastric heterotopia is present. Thus the identity of these two cases is established from both the clinical and the pathological standpoints.

tubular cyst of the same calibre as the intestine itself. At either end the cyst terminates blindly, and does not communicate with the intestine. The cyst mucous membrane does not, however, resemble that of the gut, and this makes it improbable that the wall common to the cyst and the intestine arose as a median septum within the lumen of the embryonic bowel. The cyst in all probability resulted from relics of the omphalo-meseraic duct.

Even supposing the formation of a median septum be accepted, in order that a diverticulum should form, the septum would need to gain attachment to the side wall of the bowel in order to form the blind end of the future diverticulum. No provision in the theory is made for this.

All three cases undoubtedly represent a true reduplication of the bowel, of which many other examples, of both small and large intestine, are on record. The best example of reduplication of the small intestine is Pollard's famous case, now in the R.C.S. Museum (Specimen 548 B—Teratological Series). Pollard's description of the case is as follows : " At a distance of 24 in. from the pylorus the intestine bifurcates. The two segments are similarly supplied with mesentery, so that it is only by tracing them that the diverticulum and intestine can be distinguished. The diverticulum after a course of 36 in. reaches the umbilicus, beyond which it originally terminated as a large cul-de-sac in the umbilical cord." The other segment ended at the ileocæcal valve after a course of 63 in.

Blair Aitken[16] describes a case of reduplication of the large bowel in a two-day-old child with a large umbilical hernia. Bifurcation was present from the lower end of the ileum to the perineum. One of the segments ended normally, and the other within the valvular cleft just within the posterior commissure. Bland-Sutton mentions that a French surgeon, Brignolles, discovered a double pelvic colon when operating for appendicitis. Schwalbe, quoted by Aitken,[16] records a case of double appendix ; Meckel[17] a fœtus with two cæca (originally described by Boerhaave in 1757) ; Grawitz[18] found in a man of 55 an accessory portion of bowel in a hernial sac, and arising from the ascending colon, in the form of a U-shaped segment. The limbs of the U united to form a common opening into the bowel. At the summit of the U there was a transverse occlusion.

Extreme degrees of reduplication and malformation are sometimes found. There is a specimen (No. 3631) in the Museum of St. Bartholomew's Hospital removed from a negro, in which the intestines are enclosed in a kind of sac. Three separate ilea open into the cæcum. One is small, and begins and ends in the cæcum by two orifices set close together, but the other two are of considerable length.

Reduplication is far more common in the lower animals than in man. Even triplication is sometimes found. Such deformities are most common in birds. There is a specimen in the R.C.S. Museum (D 547—Teratological Series) of the intestines of a duck with three fully-formed cæca. All are of the same length, and open into the bowel at the same level. According to Mitchell,[19] paired cæca occur normally in the hyrax and certain of the Sirenia.

It is manifestly impossible to draw a distinction between giant diverticula and the more obvious reduplications of the intestine, except in the matter of degree. Of the same order is the example of gross deformity in

St. Bartholomew's Hospital Museum, and we must seek an origin applicable to the group as a whole. It is at once apparent that septal theories of origin are inadequate.

Can the conditions be examples of reversions to type ? This hypothesis is at once put out of court for small-intestine cases by the fact that there is no animal in which reduplication of the small intestine normally occurs. The rare cases of reduplication of the cæcum may find an explanation here, however. Mitchell[19] holds, and brings forward strong evidence in substantiation, that the cæcum of primates is a rudimentary survival of an originally paired cæcum.

In the search for an origin we must study reduplication of growth as a whole. The most complete example of reduplication is that of twin organisms capable of independent existence. That twins may develop from a single ovum is an established fact. Under certain conditions, of which we know nothing, the reduplication is not perfected, and conjoined monsters may result. Many examples are to be found in the literature. Patrick[20] has recently described a thoracopagus, Cameron[21] a craniopagus, and Oag and Drinkwater[22] an ischiopagus. In the first of these cases the only unpaired structure is the small intestine above Meckel's diverticulum ; in the last the only unpaired structure is the ascending colon. It is not an impossible stride for the imagination to picture a reversal of this—pairing of a segment of the intestine in an otherwise normal individual.

Equal growth may not occur in the twins. One may reach full maturity, though not losing its connection with a fellow which has but imperfectly developed, and which constitutes a parasitic fœtus. Bland-Sutton[23, 24] has given examples of this phenomenon both in man and in animals. In these cases the stimulus to reduplication, although acting at an early stage of cell division, has affected a certain section only of the embryo, e.g., the caudal end in the parasitic calf described by Bland-Sutton,[23] or the cephalic end in the example of bicephaly of the same author.[24] The stimulus may be limited even to the cells differentiating to form a single limb, as in another case furnished by Bland-Sutton.[25] In this case an arm projects from the sacral region. Teratomata are of similar origin, but differ in that the property of proportionate growth is lacking.

Another and still less pronounced example of reduplication is the occurrence of double external genitalia. On the same analogy this may be regarded as a minor twin, the stimulus to reduplication affecting only those cells from which the genitalia are developed. Volpé's[26] case is of exceptional interest, for in this reduplication of both lower urinary apparatus and the intestine was present.

Experimentally it has been found possible to divide the fertilized amphibian ovum and produce twin embryos to the stage of completion of the gastrula.[27, 28] Attempts to produce twin embryos at a later stage have resulted in the production of *duplication of some part or parts of the body*. This fact is of extreme significance. It clearly shows not only that duplication of growth depends on forces acting upon the developing ovum, but that the extent of the duplication depends upon the stage of development the ovum has reached when the stimulus falls—thus a perfect twin in the earliest phase

of development, and a limb or a segment of bowel in a later phase, the particular part of the body affected depending upon which cells received, and reacted to, the stimulus.

The examples of giant diverticula quoted and described above are undeniably examples of reduplication of the intestine. In my opinion they owe their origin to forces acting upon the embryo during the differentiation of cells to form the primitive gut, with resulting duplication of a segment of the bowel, the forces being identical with those which determine twin growth.

HETEROTOPIA AND REDUPLICATION.

Can the occurrence of heterotopia be reconciled with the theory of origin formulated for the diverticulum ?

The primitive layer of gut is lined with a layer of entodermal cells capable of developing into any of the types of epithelium found in the course of the adult alimentary canal. What determines their development into the specialized epithelium desired of them is not known. But if the part is a malformation possessing no useful function—e.g., a Meckel's diverticulum— the primitive entoderm appears to lack control, and may exercise any of its potentialities, and develop into a type of epithelium foreign to the region of gut in which it occurs (heterotopia). This is what has happened in the diverticulum described. Present at an early stage in the development of the alimentary canal, it is lined with a single layer of entodermal cells capable of developing into any type of alimentary epithelium. They have chosen to form a double layer, intestinal and gastric. This phenomenon in no way interferes with the theory formulated for the diverticulum. It goes to show, in fact, that the diverticulum was present at a very early stage of development, before differentiation of the entoderm had commenced.

SUMMARY.

1. A case of congenital diverticulum is described which caused symptoms from infancy and eventually perforated through a chronic ulcer. The diverticulum was removed at operation, with recovery.

2. The mucous membrane of the diverticulum contains a layer of gastric mucosa, thus exhibiting the phenomenon of heterotopia.

3. Cyst-like diverticula form a distinct group of congenital diverticula of the intestine. It is thought that they develop from cysts of the intestinal wall.

4. Diverticula associated with the presence of accessory pancreatic tissue, and due, possibly, to traction by the latter, do occur, but are often difficult to distinguish from diverticula of the Meckelian type, in which pancreatic heterotopia is not uncommon.

5. Giant diverticula may occur in both the small and large intestine. They are not allied in any way to Meckel's diverticula, nor can their origin be due to growth of a median or transverse septum within the foetal intestine. Those of the small intestine cannot be regarded as atavistic. They are in all probability true reduplications of the bowel, similar to the more extreme examples of reduplication and malformations of the bowel. In the writer's

view they represent an attempt at the formation of a twin, which has come at a comparatively late stage of development of the ovum, so that the extent of reduplication is limited to a segment of the bowel.

My thanks are due to Mr. Arthur Edmunds for allowing me to investigate the case upon which this article is based, and for *Figs*. 1 and 2. To Dr. Cuthbert Dukes I am specially indebted, for without his help I should not have recognized the condition of heterotopia. My thanks are also due to Mr. S. Steward, of the Royal College of Surgeons staff, for the very beautiful coloured drawings he has prepared from microscopic sections, and to Sir Arthur Keith and Dr. Shore for permission to refer to specimens in the Royal College of Surgeons Museum and St. Bartholomew's Hospital Museum respectively.

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FRACTURES OF THE PELVIS: AN ANALYSIS OF 100 CASES.

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FRACTURES of the pelvis, whether of the individual bones constituting the pelvic girdle or of the whole pelvic girdle, are becoming progressively more frequent every year. This is in great part due to the ever-increasing number of motor vehicles which are to be seen on the roads. Deaths from motor accidents in England and Wales were: 3412 in 1925, 4075 in 1926, and 4495 in 1927. This gives an average of more than twelve deaths per diem, and it should be remembered that these figures take no account of the number of persons seriously injured or of those suffering from minor injuries.

The majority of fractures of the pelvis are caused by street accidents; other causes being severe crushes and falls from considerable heights.

Fractures involving the whole pelvic girdle are the most important owing to the consequent liability of visceral complications, such as rupture of the urethra, bladder, or intestines. These complications are emphasized in every text-book on surgery, but it is a curious fact that they very seldom result from such fractures.

The following 100 cases have come under my supervision during the years 1915–28, and occurred as follows :—

Fractures of the whole pelvic girdle	..	44
Fractures of the ilium	..	18
Fractures of the os pubis	..	24
Fractures of the ischium	..	5
Fractures of the acetabulum	..	2
Fractures of the sacrum	..	4
Fractures of the coccyx	..	3
	Total	100

Anatomical Considerations.—Before considering these fractures it will not be out of place to make a few remarks on the bony pelvis, since it is obvious that when direct trauma is applied to the pelvis the weakest parts are mainly affected.

The posterior half of the bony framework of the pelvis is subject to greater stresses and strains imposed upon it by the body weight and muscle traction and is consequently much stronger than the anterior half, which is comparatively weak. The symphysis pubis—the integrity of which depends mainly upon the subpubic and suprapubic ligaments—cannot be regarded as a strong joint, and trauma may cause dislocation of the symphysis instead of a fracture of the pubic rami. Traumatic dislocation of the sacro-iliac joint,

on the other hand, in the absence of disease of the joint, is almost unknown. The posterior sacro-iliac ligaments are some of the strongest, if not the strongest, ligaments found in the human body. The acetabulum might be regarded as one of the weak spots in the pelvic girdle, but this is far from being the case.

If the hip bone is manipulated, it can be easily recognized that by far the thickest and strongest part of the bone is a bar which extends from the auricular surface to the acetabulum. This bar may be compared to a three-sided pyramid the apex of which is situated at the upper part of the auricular surface, while its enormously thick base supports the upper part of the acetabulum. This thickened bar of bone obviously enables the hip bone to withstand the great stress of the body weight transmitted thereby from the sacrum to the head of the femur in the erect posture. There is further a second but much less well marked thickening of the hip bone extending from the tuberosity of the iliac crest (the prominent boss on the forepart of the iliac crest to which the ilio-tibial band is attached) to the upper part of the acetabulum. This thickening is again more or less pyramidal, and its base merges with that of the weight-resisting bar at the upper part of the acetabulum. *Fig. 5* represents the medial aspect of the right hip bone. The bone is supposed to be translucent in order to appreciate the relative positions of the auricular surface and the acetabulum. In order to appreciate the positions and form of the two strengthening bars the actual thickness of the bone in its various parts is indicated by stippling.

If a section is made through the hip bone in a plane corresponding to a line drawn from the upper part of the auricular surface to the acetabulum, it will be seen (*Fig.* 6) that the strength of the weight-resisting bar of the bone does not depend alone on the actual thickness of the bone, but also upon a

Fig. 5.—Diagrammatic representation of the medial aspect of the right hip bone. The thickness of the bone is indicated by stippling; the denser the stippling the thicker the bone. A, The thickened bar stretching from the upper part of the auricular surface to the upper part of the acetabulum, the latter being by far the thickest part of the bone; B, The less well-marked bar stretching from the tuberosity of the iliac crest and merging with A at the upper part of the acetabulum.

peculiar and remarkable arrangement of the bony material. In the cancellous tissue two sets of pressure lamellæ may be seen diverging from the auricular surface and impingeing upon two relatively very thick interjections of the surface compact bone on either side. These interjections are comparable with the calcar femorale upon which the resistance of the inner

side of the neck of the femur is so largely dependent; from them spring two sets of lamellæ which converge on to the upper part of the acetabulum, where again the compact bone is remarkably thick. There are thus two sets of lamellar arches in the cancellous bone interposed between the auricular surface and the acetabulum, inverted as regards one another and supported by buttresses of compact tissue. A more adequate arrangement for resisting stress cannot well be imagined. This peculiar cancellous tissue occupying the interval between the auricular surface and the acetabulum is sharply demarcated from the more or less round-meshed cancellous tissue occupying the upper and hinder part of the bone which is subject to the pull of muscles and ligaments and does not directly resist the body weight.

An interesting fact which may be gathered from examining sectionized bones of young subjects is that the two supporting bars of the hip bone are not noticeable at birth, are obvious at the end of the first year, and become very distinct by the third year.

Certain well-known features of pelvic fractures now become intelligible. Owing to the resistance which the bases of the two thickened bars of the hip bone confer upon the upper part of the acetabulum, fractures of the acetabulum, and especially of the upper part of the acetabular lip, are of relatively infrequent occurrence. In most cases of fracture of the ilium the lines of fracture do not pass downwards and forwards from the point of application of the trauma, but invariably stop short in the region of the main bony bar.

Fracture of the Whole Pelvic Girdle.—An examination of 44 cases of fracture of the whole pelvic girdle and a comparison of their skiagrams make it clear that there are two common types :—

1. The first type is one in which the fracture is oblique in nature, causing a solution in continuity of the pubic rami on one side and an irregular fracture of the sacrum and posterior part of the iliac crest on the other. Most of these cases were the result of the patient having been run over either by the wheel of a cart or by a motor-car. The initial force is borne by the pubic rami, and as the vehicle passes over the pelvis the body rolls over with the wheel and the final force is directed to the opposite side. Sometimes the fracture runs through the horizontal ramus of the pubis and the ascending ramus of the ischium, while in other cases the body of the pubis is fractured (*Fig.* 7).

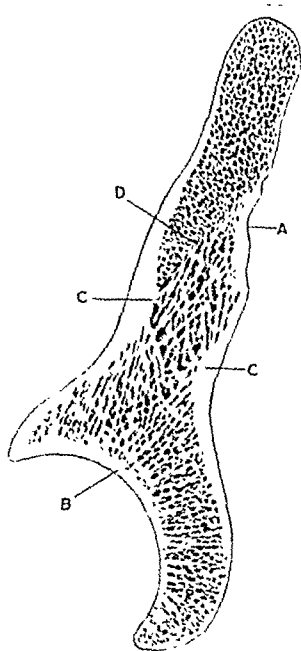Fig. 6.—Section through the hip bone passing through the thickened bar stretching from the upper part of the auricular surface, seen in profile (A), to the acetabulum (B). The peculiar arrangement of the cancellous tissue in this bar, the two interjections of compact bone (C), and the sharp line (D) demarcating the cancellous tissue occupying the upper and lower parts of the ilium, may be noted.

The pelvis as a whole is a compressible girdle, more particularly in children, many of whom have been run over by light cars where the wheels have passed over the pelvis and no fracture has resulted. This is no doubt due to the elasticity of the pelvis as a whole—a characteristic which is notable in young subjects but diminishes as age advances. The lateral masses of the sacrum are stronger behind than in front, a fact associated with the very strong posterior sacro-iliac ligaments which are there attached, and with the anatomical fact that the sacro-iliac joint is supported posteriorly by the posterior part of the iliac crest.

In some cases the fracture through the posterior part of the pelvic girdle involves the lateral mass of the sacrum only, and the posterior part of the iliac crest is uninjured.

2. The second type of fracture of the whole pelvic girdle is one in which the fracture is limited to one side only. The common cause of this lesion is an antero-posterior compressing force such as a severe crush. This type is not so common as the former, although it is fairly frequent in 'shunters', who are liable to accidents from the compressing force of the buffers of railway trucks. Complications are more likely in

FIG. 7.—Oblique fracture of the pelvic girdle. The lateral part of the sacrum and the upper and hinder part of the ilium are fractured on the left side ; the bones bounding the right obturator foramen *above and to the medial side* are fractured on the right side.

this second type, owing, no doubt, to the fact that the initial force is greater and more sustained. As a rule the fracture traverses the rami of the os pubis and ischium and the anterior sacral foramina on the same side (*Fig.* 8).

FIG. 8.—Fracture confined to one side of the pelvic girdle. The lateral part of the sacrum, the bones bounding the obturator foramen above and below, are all fractured on the left side.

In some cases where the trauma is very great the sacrum may be fractured on both sides and driven into the pelvic cavity ; these are usually fatal, and no such example is recorded in my series. Vergorz[1] reported a few cases in which a double fracture occurred and a fatal result did not ensue.

The diagnosis of a case with a fracture of the whole pelvic girdle usually presents little difficulty. Many cases come under observation in a state of shock, and it is noticed that the pelvic girdle appears to be 'splayed' ; the abdomen seems to be continuous with the thighs, and there is no indication of the fold due to Poupart's ligament. The patient complains of pain in and about the os pubis and will often remark that he feels as if he were 'falling to pieces'. Usually there is considerable pain on coughing. Careful palpation will in many cases demonstrate a fracture in the pubic bone. On no account should an attempt be made to elicit crepitus, as by so doing damage to the membranous urethra may result, or if this structure is already torn, the rent may be made worse. Examination of the rectum may reveal a fracture of the sacrum.

The chief dangers which may co-exist with a fractured pelvis are certain visceral lesions, such as damage to the urethra, bladder, or rectum. It is most important to exclude any of these complications when the case first comes under observation. The membranous portion of the urethra which occupies the interval between the two layers of the triangular ligament is the part of the urethra most likely to be torn, especially if there is any displacement of the pubic rami or of the symphysis. The injury to the bladder may cause an extra- or intraperitoneal rupture depending mainly on the force of the trauma and the degree of the distension of the organ. The rectum may be punctured by displaced fragments of bone, but this complication did not occur in any one of my series, and must be a very rare one.

The treatment should be prompt. Every care should be taken when the patient is moved, as if any visceral complications are present, they may be easily increased by movement. The patient should be put to bed on a divided mattress with fracture boards beneath it, and kept warm and quiet until the shock has passed off. A rubber catheter should be passed and the urine drawn off and examined; if it is blood-stained, the catheter should be tied in. If it is impossible to pass a catheter owing to laceration of the urethra, a perineal incision must be made to prevent urinary infiltration, and the rent in the urethra sutured over a rubber catheter. A broad binder should be firmly applied to the pelvis and kept in position for ten days, when plaster-of-Paris breeches should be applied. The fixation in plaster ought to be maintained for fully six weeks, after which it can be removed and the patient allowed to move about in bed. A skiagram should be taken to ascertain the amount of union and callus formation: active and passive movement may then be commenced. The patient should be allowed up on crutches after nine weeks, and will usually be able to discard these after three weeks—that is, three months from the time of the accident. In cases where there is a difficulty in determining whether a rupture of the bladder is intra- or extraperitoneal it is better to open the peritoneal cavity first, as suggested by Sir William Wheeler.[2] Any urine or blood in the peritoneal cavity should be removed by means of a siphon, the rent in the bladder repaired, and a catheter tied in. If the rupture is extraperitoneal, the site of the rent is usually on the anterior surface; the opening can easily be closed, a drainage tube should be passed into the cave of Retzius, and a catheter tied into the bladder. Very rarely the rent in the bladder is near the base. In these cases it may be impossible to insert any stitches, and the surgeon will have to resort to suprapubic cystotomy.

In cases where the wall of the rectum is definitely lacerated owing to the penetration of a fractured portion of the sacrum, the best method is to perform a colostomy at once in order to prevent any pelvirectal suppuration.

In 1926 Gardner[3] reported a case of fractured pelvis with insignificant skin abrasions and no crushed or extensively devitalized part. This patient died from a fatal infection caused by the *Bacillus welchii*. Such a complication must be very rare.

An analysis of 44 cases of fracture of the pelvic girdle shows that there were 32 males and 12 females. The causes in this type of fracture were: Accidents caused by vehicles 30; crushes 8; falls from windows, etc. 6.

In 28 out of the 44 cases the type of fracture was oblique (*see Fig.* 7) ; in the remaining 16 cases the fracture was limited to one side or other of the pelvic girdle (*see Fig.* 8).

Visceral complications occurred in 6 cases only ; 5 of these were in men and the other case was that of a girl, age 8. All these were run-over cases, and in every instance the fracture of the pelvic girdle was oblique. The visceral complications were as follows : 3 cases of rupture of the urethra ; 3 of rupture of the bladder (2 extraperitoneal, 1 intraperitoneal). In this series of 44 cases there was not one in which the rectum was injured.

Fracture of the Ilium.—The 18 cases of fracture of the ilium were all caused by direct traumatism (*Fig.* 9): 12 cases occurred in males and 6 in females. Street accidents accounted for 11 cases ; 2 were caused by a kick from a horse, and 5 were due to falls, generally from a height varying from three to ten feet.

FIG. 9.—A stellate fracture of the left ilium caused by direct traumatism.

There were no visceral complications : the one and only trouble in the 18 cases was a large hæmatoma in the iliac fossa ; but this gradually diminished in size and eventually disappeared. They all showed varying degrees of comminution, but in every case sound union was obtained. Such a result would be expected in these fractures, although in some the degree of comminution was very great, because the ilium is closely invested with muscles on either side, and these muscles in themselves provide excellent splints.

The treatment in this type of fracture is similar in every way to that advised in cases where the whole pelvic girdle is involved. Although avulsion of the anterior, superior, or inferior iliac spines does occur, I have never come across a case.

FIG. 10.—Fracture confined to the os pubis. The two rami of the os pubis are fractured on the left side.

Fracture of the Os Pubis by Itself or of its Rami.—This seems to be the second commonest type of fracture of the pelvis, and occurred in 24 cases in my series (*Fig.* 10): 14 patients were males and 10 females. The causes of the fractures were : Accidents caused by vehicles 16 ; crushes 4 ; falls 4.

Visceral complications occurred in 5 cases, and these all resulted from being run over by vehicles. In 3 male cases the urethra was ruptured ; in 2 extraperitoneal rupture of the bladder occurred—one in a male and the other in a female.

The treatment in this type of fracture is similar to that in which the whole pelvic girdle is injured.

Fracture of the Ischium.—This is an uncommon form and was met with in 5 cases only. All the cases occurred in men, and were the result of a heavy fall on the buttocks ; in 4 the tuber ischii alone was fractured and

there was practically no displacement. In one case the whole ischium was fractured with slight displacement of the fragments.

These patients were treated by rest in bed for a period of six weeks, then massage was given for two weeks and the patients were allowed up for a short period, after which they were discharged. Union was good in every instance and there was no disability whatever.

Fracture of the Acetabulum.—Only two cases of this condition occurred in my series :—

The first case was a fracture of the posterior lip in a man, age 38, who was thrown from his horse, his left leg becoming entangled in the stirrup. He was dragged along the ground for ten yards or so, when his horse attempted to jump a hedge and his foot slipped out of the stirrup. On examination he was found to have a posterior dislocation of his left hip-joint, and X rays showed that the posterior lip of the acetabulum was fractured. The dislocation was reduced under anæsthesia, and the leg put up on extension with external rotation and abduction for two weeks. After this the pelvis and thighs were immobilized in plaster-of-Paris breeches for six weeks. Owing to the extensive bruising of the soft parts it was considered unwise to immobilize the pelvis in plaster immediately after the accident. When the plaster was removed it was found that firm union of the fracture had taken place. The patient was not allowed to put any weight on his left leg for another three weeks, but was permitted to walk about with the use of crutches. No disability whatever resulted.

The second case occurred in a girl, age 12, who was knocked off her bicycle by a motor-cyclist. She was thrown on to the edge of the pavement, and sustained a stellate fracture of the acetabulum. The force in this case was transmitted through the neck and head of the femur as the point struck was the great trochanter of the femur. The patient was treated with weight extension for two weeks and then immobilized in plaster for six weeks. Walking was permitted after three months. It might be thought that walking would have been allowed after two months, but as in this case the Y-shaped acetabular cartilage must have been severely traumatized, it was thought advisable to keep the girl off her feet, otherwise there was a definite risk of imperfect growth of the ossific centre of the acetabulum. A good anatomical and functional result was obtained.

Although fractures of the anterior lip and fractures through the centre of the acetabulum (central dislocation of the hip) have been described, no such examples occurred in my series of cases.

Fracture of the Sacrum.—This is always due to severe local direct violence. Four cases occurred in the present series, the two sexes being equally affected. The cause of the fracture was a kick from a horse in two cases, and a fall on to the edge of the pavement in another, while the remaining case was due to a kick during a game of football.

In none of these cases was there much displacement, although in two, where the fracture traversed the 4th sacral segment, the lower end of the sacrum and the coccyx projected forwards and could be easily felt on rectal examination. The rectum was not injured in any of the four cases. One of the female patients developed some neuralgia of the 4th sacral nerve,

probably owing to callus formation. The treatment adopted was similar to that of fracture of the whole pelvic girdle.

Fracture of the Coccyx.—This condition is not so uncommon as might be imagined, three cases being noted in the hundred under review. One occurred in a man who slipped off a window-sill while cleaning an outside window; he fell about four feet and landed astride a water bucket. The other two cases occurred in women and were due to falls on the buttocks.

In all these cases the coccyx was displaced forwards, but was easily replaced into its normal position by manipulation with a finger in the rectum. The patients were treated simply by rest in bed. The man did very well; the union was sound, and when seen a year after the accident he reported that he had no pain or discomfort. The other two cases did well for a time; in one case the coccyx united in a bad position and was excised; in the other the patient remained well for eighteen months, when coccydynia developed, and, palliative means proving useless, excision of the coccyx was carried out two years after the accident.

SUMMARY.

1. In this series of 100 cases of fracture of the pelvis it is surprising to find that in 11 only were there any visceral complications.

2. The small number of cases in which visceral complications occur is not really so surprising as appears at first sight, when it is considered that quite a large proportion—due to their being run-over cases, where the pelvis is fractured and multiple visceral injuries are found at autopsy—are immediately fatal. The typical case of fracture of the pelvis of thirty years ago, when run-over accidents were not nearly so often fatal as at the present day, was caused by the wheel of a cart; while nowadays the non-fatal cases are caused by the comparatively small pneumatic wheel of the ordinary motor-car. The fatal cases of to-day are caused mainly through being run over by a lorry, a motor-bus, or a heavy motor-car.

3. There was no case of injury to the rectum.

4. There was no case of injury to the sacral nerves at the time of the accident and only one at a later date due to compression from excessive callus formation. This is not surprising, as the sacral foramina are roughly double the size of the nerves they transmit, and there is, therefore, ample room for some callus formation without encroaching upon the nerves.

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AN INCISION FOR DIRECT EXPOSURE OF THE WHOLE HUMERUS.

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THE incision here described is of special use in those cases which require direct exposure of the whole humerus. It is also convenient in those more commonly occurring cases where only one segment of the bone seems to need exposure, because, if required, it can be easily extended upwards or downwards with relative impunity. A convenient position is to have the arm by the side, with the pronated and semiflexed forearm lying across the trunk. The line of the incision (*Fig.* 11), commencing above, extends from the clavicle immediately internal to the tip of the acromion. Passing down the arm along the outer border of the biceps, it terminates at the middle of the bend of the elbow. The incision is deepened (*Fig.* 12) to reach the deltoid, which is split in the direction of its fibres. This cleavage is approximately along the line of junction of the small clavicular and larger scapular portions of the muscle, and passes below through the apex of its v-shaped insertion. Continuing downwards, the brachialis is split in the direction of its fibres

FIG. 11.
Line of incision.

FIG. 12.
Direct exposure of humerus.

along the anterior ' crest ' of the humerus, until the anterior capsular fibres of the elbow-joint are exposed below. No important structure is endangered if the incision is deepened through the periosteum and that membrane stripped from the bone by blunt dissection.

The following are some of the advantages of this incision :—

1. The cephalic vein is not interfered with, possibly a matter of importance in infected cases.

2. The musculospiral (radial) nerve is not seen, unless especially sought for amongst the muscular mass retracted outwards. It is closest to the bone

as it lies posteriorly in its groove. Even in this situation, and in normal subjects, the periosteum can be easily stripped away, carrying with it and protecting the nerve. This is, of course, even more marked in those cases where disease has thickened the membrane.

3. The musculocutaneous nerve in the lower part of the incision lies on the portion of the brachialis which is displaced inwards. Even when the incision is extended down to the elbow-joint this retraction of the muscle usually displaces the nerve out of harm's way.

4. That part of the brachialis which is external to the incision is said to be supplied by a branch from the musculospiral nerve.

5. The innervation of the anterior portion of the deltoid is by a special high branch of the circumflex nerve (*Fig.* 13). This is not endangered unless the incision is carried for approximately $1\frac{1}{4}$ in. above the level of the circumflex vessels as they cross the humeral shaft. If the incision is made at this high level, it is usually possible with care (as shown in *Fig.* 13) to recognize the nerve, mobilize it, and divide the periosteum deep to it. Even if this twig has to be divided, only a small (actually slightly less than a quarter) clavicular portion of the deltoid will be thrown out of action. The work of the paralysed part can be ' taken on ' by the adjacent fibres of the pectoralis major.

6. The incision is simpler than that described by A. K. Henry,[1] more especially as the difficulty and added risk of mobilizing and dealing with the clavicular chip, with the attached anterior fibres of the deltoid, are avoided, even when exploring the highest limits of the bone.
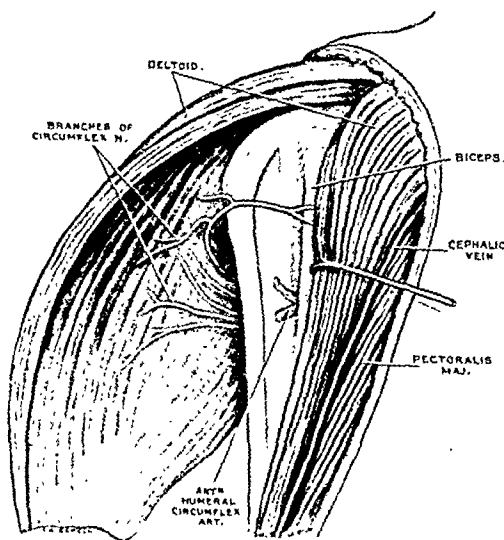
Fig. 13.—Innervation of right deltoid.

CASE REPORT.

The following is illustrative of a type of case in which this incision is useful :—

I. B., girl, age 11 years and 9 months, was admitted to hospital on Nov. 8, 1926, as an emergency case. She complained of a painful and swollen right arm. The condition was said to have been of a week's duration, and the severity of the pain had been such as to prevent sleep.

ON EXAMINATION.—The child was very ill. The temperature was 102° and the pulse-rate 130 per minute. The whole of the right arm (shoulder to elbow) was glassy, swollen, and exquisitely tender. Although the swelling involved both the shoulder and elbow regions, the impression was formed that the inflammatory process was confined to the humerus. There was no evidence of pyæmic dissemination.

OPERATION.—Under open ether anæsthesia the right humerus was exposed by the incision as already described. The incision opened the periosteum and was carried at least an inch higher up the bone than the circumflex vessels, which were divided. Subperiosteal collections of pus were evacuated from almost the entire length of the humeral shaft. The exposed antero-lateral aspect of the bone was freely removed, pus liberated from the medulla, and the wound

FIGS. 14. 15.—Functional results eighteen months after original operation.

FIG. 16.—Skiagram of humerus eighteen months after original operation.

lightly packed. The child was critically ill for the next twenty-four hours, but after that soon commenced to improve.

During the next year several operations were performed—some for the removal of sequestra, whilst others were manipulations aimed at the restoration of joint movements. The wound finally healed in November, 1927.

Eighteen months after the original operation the child was examined and found to be in good health. At the shoulder-joint there was a normal range of movements. Extension at the elbow-joint was somewhat limited, but

flexion, supination, and pronation were good. *Figs.* 14, 15 illustrate the arm movements that were possible; the skiagram (*Fig.* 16) reveals the late condition of the bone. The division of the deltoid having been carried upwards for rather more than an inch above the level of the circumflex vessels, it is interesting to note that both portions of the deltoid (i.e., those on either side of the scar) reacted in an exactly similar manner to electrical stimulation.

REFERENCE.

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DEVELOPMENTAL ENTEROGENOUS CYSTS AND DIVERTICULA.

(Based on a Hunterian Lecture delivered at the Royal College of Surgeons of England on Jan. 28, 1929.)

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CASE REPORT.

A MALE, age 29, was admitted on Oct. 17, 1925, into Westminster Hospital complaining of ' pain in the lower part of the abdomen '.

In April, 1923, the patient first experienced his attacks of pain, which occurred at intervals of about three hours, for a period of seven days. Each attack consisted of griping pain over the whole lower abdomen lasting for about fifteen seconds ; this was occasionally followed by pain in the epigastrium, lasting for a shorter period. The griping pain was severe and ' doubled him up '. The patient kept at his work during the whole of the week. The pain bore no relation to the ingestion of food or to exertion. During this week there was loss of appetite and malaise. There was no constipation or diarrhœa. The patient has always had a daily action of the bowels without taking drugs. A similar bout of these attacks occurred later in 1923, another in 1924.

In September, 1924, whilst lying in bed he experienced a strange sensation (described as ' heaviness ') in the right side of the abdomen, and on examining the site found a ' lump ' there. This lump has appeared many times since ; it stays for a minute or less, then passes away—occasionally with a slight gurgle. If rubbed the swelling disappears at once ; it is painless, and its presence seems to have no relation to the occurrence of pain.

In February, 1925, there was another series of painful attacks, occurring at intervals of about two hours. These were repeated in June and September. The patient was seen in the out-patient department and admitted into the wards with a diagnosis of tumour in the right side of the abdomen.

When I first examined the man I could detect nothing abnormal in the abdomen other than an easily palpable cæcum, and I wondered at the previous diagnosis. I saw the patient the following day and again could detect only this palpable cæcum ; but as I watched the abdomen an obvious tumour developed in the line of the ascending colon. The anterior abdominal wall bulged forward over a circular area about four inches in diameter, the centre of which was raised about one inch above the level of the surrounding abdominal wall. On palpating this a tumour about the size of a cricket ball could be felt ; in a few seconds the tumour softened and faded away. There was no doubt then that the ' lump ' was a piece of gut, either the distended cæcum or a portion of the ascending colon.

Operation.—On opening the abdomen, the cæcum was seen to be larger than normal. About the middle of the ascending colon a strong, wide,

vascular band of adhesions was found extending from the outer to the inner border of the colon, somewhat constricting the gut. I divided this, along the line of the anterior tænia coli, and the constricted portion of the gut distended to the size of the neighbouring colon.

The vermiform appendix was, save for the terminal inch, adherent to the posterior surface of the cæcum, and was removed. On palpating the cæcum a cystic swelling could be felt in its interior; this was continuous below with the wall of the cæcum, but its upper end was free in the lumen of the gut. On opening the cæcum the condition shown in *Fig.* 17 was discovered. The cystic swelling was covered by the mucosa lining the gut. I endeavoured to enucleate the cyst through an incision made through the outer coats of the cæcum at its lowest extremity, but failed; the wall of the cyst was continuous with the muscular wall of the cæcum. In this attempt I opened into the cyst, and a milky mucoid fluid escaped. The cæcum and adjoining ileum were then excised and an anastomosis made between the end of the ileum and the side of the ascending colon.

The interior of the cyst was at once packed tightly with wool and the whole specimen placed in dilute formalin. As a result of this the cyst did not share in the general shrinkage process, and now presents the appearance of being partly extracæcal.

FIG. 17.—Developmental enterogenous cyst of the cæcum. The ascending colon and cæcum are laid open by a vertical section, the cyst being thus exposed. No part of the cyst is really extracæcal. A, Ascending colon; B, The site from which the section shown in *Fig.* 18 was taken; C, Intracæcal part of cyst; D, Ileocæcal junction; E, Ileum; F, Intramural part of cyst; G, Anterior tænia; H, Right tænia. (×⅗.) (*See* Lotheissen's case, p. 64 and *Fig.* 47.)

This, however, is only apparent; the cyst is almost entirely intracæcal and partly intramural. The recovery was uninterrupted.

REPORT ON A SPECIMEN OF CYST OF THE CÆCUM.

By Sir Arthur Keith.

The relations and characters of this cyst are shown very clearly by Mr. Sewell's drawing (*Fig.* 17), which represents the specimen as now mounted in the Museum of the Royal College of Surgeons.

The cyst is a large sausage-shaped structure, one part lying within the cæcum, the other extruding from the fundus of that organ. These two parts —extracæcal and intracæcal—are of about equal size. The total length of the cyst in its state as now exhibited is 14·2 cm. long, with a diameter of 5 cm. in its extracæcal part and 4 cm. in its intra-cæcal. Although part of the cyst is de-scribed as extracæcal, this is true of the appearance rather than of the reality.

The nature of the cyst, which is cer-tainly developmental in origin, is brought out by the study of a section of its wall such as that represented in *Fig.* 18. The site of this section is indicated in *Fig.* 17 at the highest point of the intracæcal part of the cyst. The section shows that walls of both cyst and cæcum are included.

The cyst is lined by a stratified epi-thelium $30\,\mu$ thick, the basal layer of the cells being columnar, while the upper stratum—two or three cells in depth—shows elements which are cubical, flat-tened, or transitional in shape. Nowhere does the epithelium form glandular crypts, and yet in my opinion it must be regarded as representing the lining membrane of the alimentary canal. The distension of the cyst has probably led to flattening and atrophy of its epithelial lining.

The section shows, next to the epithe-lial lining, a dense submucous layer, only $40\,\mu$ in thickness; then comes a double coat of musculature, made up of circular and then longitudinal elements, the total muscular stratum being $400\,\mu$ thick. In most parts there are but two muscular layers, an inner circular and an outer longitudinal, but at certain points there are as many as four alternating layers. Outside the muscular coat of the cyst proper comes a stratum of loose fibrous tissue. Then come two muscular coats, a longitudinal and a circular, clearly repre-senting the muscular coats of the cæcum, the fibrous tissue—between the muscular

FIG. 18.—A section made of the cyst wall at the site shown in *Fig.* 17 B. A, Stratified epithelium; B, Submucous layer; C, Circular muscular coat; D, Longitudinal muscular coat; E, Loose fibrous tissue; F, Longitudinal muscular coat; G, Circular muscular coat; H, Sub-mucous coat; I, Tubular glands—coiled ends of Lieberkühn's glands; K, Mucous coat.

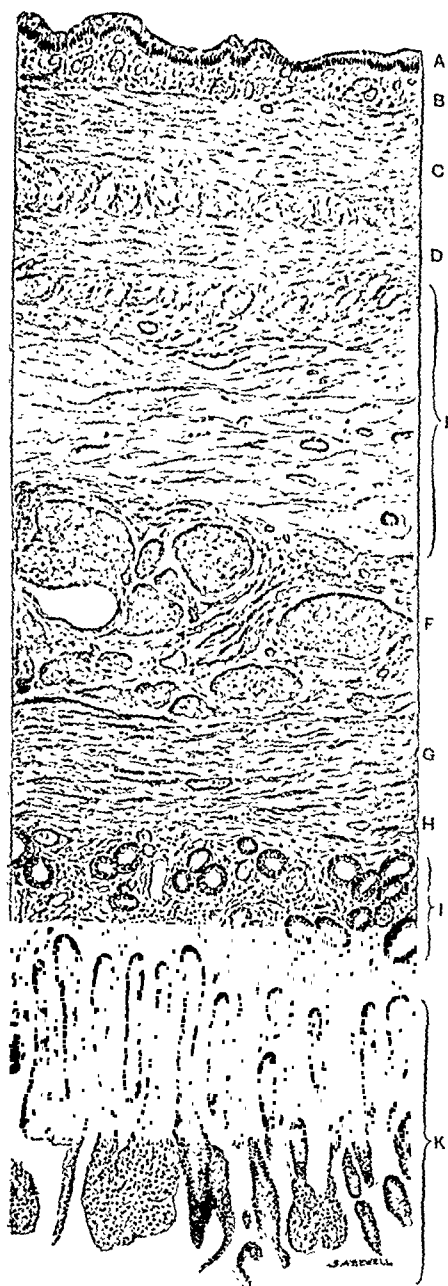coats of the cæcum and cyst—corresponding to the fused subperitoneal tissues of both structures. The combined muscular coats of the cæcum measure 700 μ in thickness, but in neither the cæcal nor the cystic musculature can the myenteric (Auerbach's) plexus be traced.

Then follow the submucous coat of the cæcal series (300 μ in thickness), and lastly the mucous coat, which is 900 μ in depth, being made up of elongated closely set tubular glands—glands of Lieberkühn. The muscularis mucosæ is very imperfectly separated, the reason of this being seen in *Fig.* 18. There it will be seen that at the bases of the tubular glands and the site of the muscularis mucosæ there occur coiled ducts laid open in circular and oval sections. There can be no doubt, I think, that these glandular structures represent the coiled ends of glands of Lieberkühn, but they do not occur as a continuous stratum, being absent in some parts. A section of a normal part of the cæcum shows a mucous membrane only 500 μ in thickness, against 900 μ over the cyst wall, while the muscular coat over a normal part of the cæcum has the same thickness as seen in this section. The section first examined reveals a double wall, one pertaining to cyst, the other to cæcum, and shows that the same strata are represented in each.

When a section of the extracæcal part (*Fig.* 17) of the cyst is examined the same strata are encountered as have been enumerated in the intracæcal part of the cyst wall—namely, a lining of transitional epithelium, a thin submucous layer, then a double muscular coat, and lastly one which represents peritoneum and subperitoneal tissue.

In *Fig.* 17 it is shown that the cyst is situated immediately behind the ileocæcal orifice ; there the walls of cyst and cæcum fuse. The mucous lining of the cæcum is reflected on the intracæcal part of the cyst at a level which lies slightly below that of the ileocæcal orifice.

At first sight it looks as if the congenital cyst which occurs in the mesentery of the ileocolic angle, of which there is an excellent example in the R.C.S. Museum, No. 1220.01, and the cyst here described, could not be members of the same series. In both kinds the construction of the cyst wall is exactly the same ; both represent developmental diverticula of the fœtal alimentary canal, the original opening into the canal becoming obliterated. A study of published cases brings to light forms which are transitional in position between the intramesenteric and the intracæcal forms. I therefore conclude that in the present case the cyst found within the cæcum is a variant of the more usual intramesenteric or ileocolic form.

Why the ileocolic angle should be the usual site at which congenital cysts occur we can give no satisfactory explanation. In no animal do we find any normal diverticular or glandular outgrowth formed at the ileocæcal junction, save the cæcal diverticulum, which in birds is double. There is no reason for regarding ileocæcal cysts as the representative of one half of a bifid cæcum.

ORIGIN.

There can be no doubt that cysts whose walls reproduce completely or incompletely the structure of gut, whether discovered in the wall of the gut, attached to the gut, or even more or less remote from the gut, must have

been derived from the gut. They are enterogenous cysts, and they originated as diverticula in the manner described by Keibel[1] and by Lewis and Thyng.[2] They are developmental enterogenous cysts.

Lewis[3] thus describes the formation of diverticula in the jejunum and ileum : The epithelium contains scattered vacuoles which develop in a characteristic manner. The vacuoles are first indicated by a concentric arrangement of the basal nuclei, and in this stage they have been described as 'buds' or 'pearls'. In the centre of such a bud a small cavity can often be detected (*Fig.* 19 *A*). In later stages the cavity communicates with the intestinal lumen, and the bud forms a knob-like basal projection (*Fig.* 19 *B*). These projections often have a somewhat constricted neck, and the overhanging portion may become asymmetrical, extending aborally along the intestine.
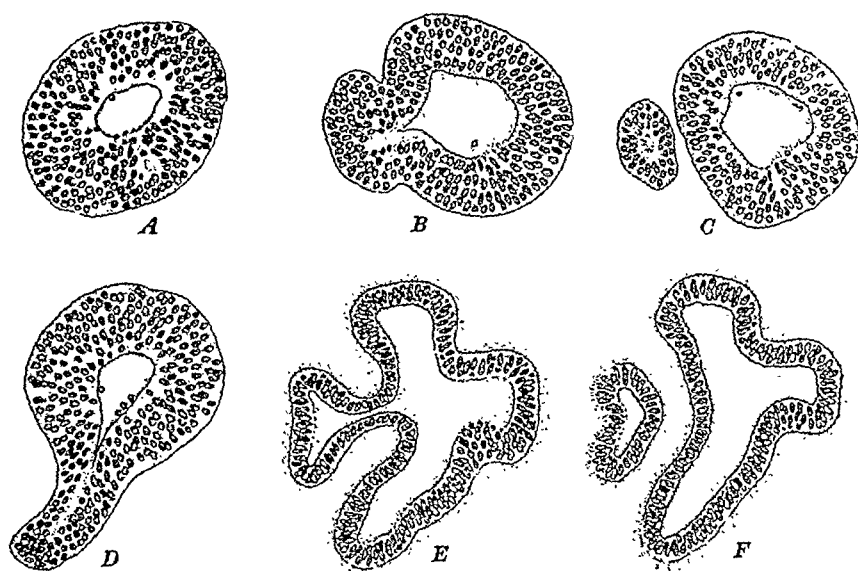
FIG. 19.—Cross-sections of the epithelial tube of the intestine, showing the development of diverticula. *A* to *D* from a 22·8-mm. embryo. *E* and *F* from a 30-mm. embryo. (× *130.*) (*From Keibel and Mall*, ii, 384.)

Thus *Fig.* 19 *C* is an aboral section of the diverticulum shown in *Fig.* 19 *B*. Four of the thirty-two diverticula in a 22·8-mm. embryo project aborally. One diverticulum, longer than any of the others, extends laterally so that its tip penetrates the dense mesenchyma of the muscularis (*Fig.* 19 *D*).

Usually they are in close relation with the epithelial layer, and they cause no disturbance in the course of the muscular fibres. In older embryos (*Fig.* 19 *E* and *F*) the folded appearance of the epithelium renders the detection of the diverticula more difficult. It is probable that, by the enlargement of their necks, some of them are incorporated in the general epithelial layer. Others, however, retain their identity.

Summing up their examination of 24 pig embryos, Lewis and Thyng state that in pig embryos from 5·5 mm. to 14 *mm. in length*, one or two knob-like diverticula occur regularly in the duodenal region (*Fig.* 20). In embryos from 14 to 24 mm. the number of diverticula increases, and they are

distributed along the small intestine. None was found in the large intestine, except in the 32-mm. specimen, where a cluster of diverticula occurred near the ileum. The diverticula appear first in the duodenum and later in the lower portion of the small intestine. They begin as round knobs which may become elongated and detached from the intestine in the form of nodules, strands, or cysts. In later stages they acquire a lumen, and those found in the distal part of the small intestine appear as flask-shaped gland-like pockets. The rabbit embryos which were examined indicated that the diverticula begin to develop at 12 days. A 5-mm. rabbit of 12 days examined showed a pearl-like disturbance of the epithelial cells, suggestive of the later pockets. In a 7·5-mm. embryo of 13 days there was a round pocket with a lumen emptying into the intestine just beyond the duct of the dorsal pancreas. In this embryo there were also three pearls along the anterior limb of the intestinal loop. In a 14-day embryo there was a duodenal pocket near which was a detached epithelial nodule, containing a lumen. There were also four pearls along the anterior limb of the intestinal loop.

FIG. 20.—A reconstruction from a pig embryo of 5·5 mm., in which it is seen that the intestinal epithelium presents a knob just below the dorsal pancreas. A section through this is shown in *Fig.* 21 A. A, Vesica fellea ; B, Stomach ; C, Pancreas dorsale ; D, Diverticulum ; E, Pancreas ventrale. (*After Lewis and Thyng*, '*American Journal of Anatomy*', 1907–08, vii.)

A pig embryo of 17 mm. showed nine diverticula, most of which had a lumen communicating with that of the intestine. They began below the pancreas and were distributed along the duodenal region and anterior limb
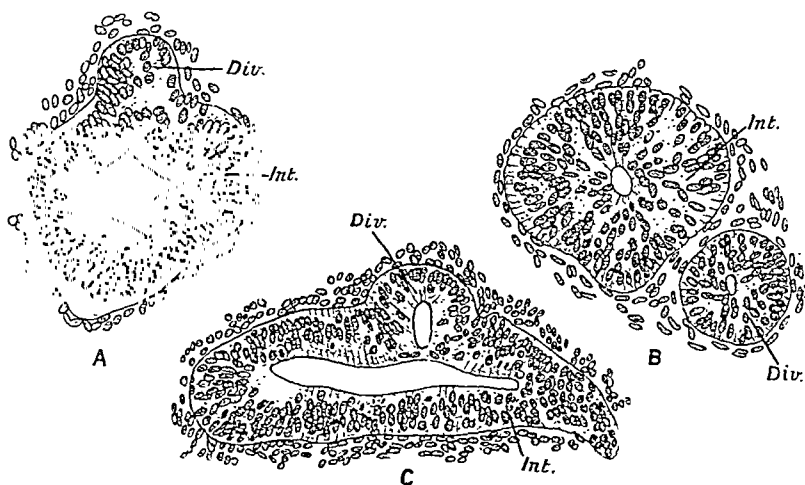
FIG. 21.—A, Section through the intestine (*Int.*) and diverticulum (*Div.*) in a pig embryo of 5·5 mm. (× 150.) B, Similar section from a human embryo of 13·6 mm. In adjacent sections the diverticulum was shown connected with the intestine. (× 150.) C, Similar section from a rabbit embryo of 11 mm. (14 days). (× 100.) (*After Lewis and Thyng*, '*American Journal of Anatomy*', 1907–08, vii.)

of the intestinal loop. Another had ten diverticula and one detached nodule. At 16½ days (18·8 mm.) there were six pockets, each with a lumen. The largest was in the duodenum, and others in the coiled part of the small intestine, separated from the first by a considerable interval. They did not decrease regularly in size towards the colon.

In a rabbit of 41·6 mm. a single pocket was found. It was shaped like a flat round flask, and set in the epithelium so that it produced only a slight bulging of the basement membrane. It had an oval lumen emptying into the intestine and was lined with smooth epithelium, contrasting with the much-folded intestinal layer which was in process of forming villi.

In a human embryo of 13·6 mm. Lewis and Thyng described a duodenal diverticulum (*Fig.* 22). Below the duodenal pocket there were indications of diverticula formation at twelve places along the small intestine. There were transitions between well-defined diverticula and slight irregularities of
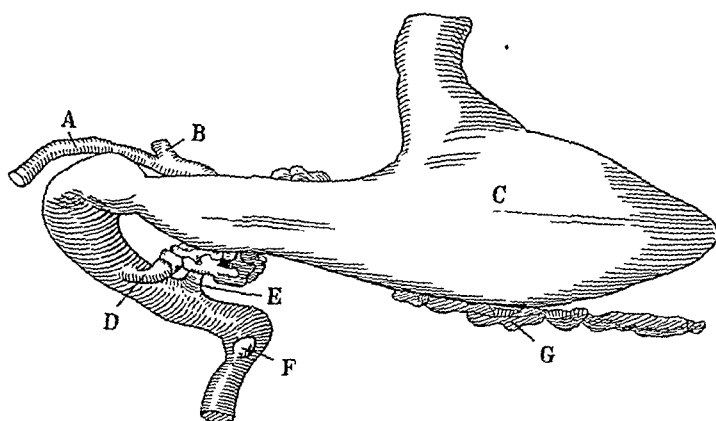
Fig. 22.—Reconstruction of a human embryo of 13·6 mm. showing a duodenal diverticulum. (× 35.) A, Cystic duct; B, Hepatic duct; C, Stomach; D, Ductus pancreatis dorsalis; E, Common bile-duct; F, Diverticulum; G, Dorsal pancreas. (*After Lewis and Thyng*, ' American Journal of Anatomy ', 1907–08, vii.)

the epithelium. In a human embryo of 23 mm. there were thirty-three well-developed diverticula along the small intestine; there were none in the ileocæcal region or in the large intestine. In a more advanced embryo the epithelium in the proximal part of the small intestine was greatly folded and had shrunk from the mesenchyme so that diverticula—even if present— would have been difficult to recognize; but within the umbilical cord the intestine was well preserved, and forty-eight diverticula were counted. In none of these human embryos were diverticula found along the large intestine and vermiform appendix. Originating in the manner described, it is clear that this abnormality may persist as a diverticulum, its lumen communicat- ing with the lumen of the intestine, or it may become a completely closed sac, having no communication with the gut lumen. Lewis and Thyng described this process in a pig embryo. A 20-mm. pig embryo has twelve diverticula in that part of the small intestine which is preserved. There are none along the large intestine. The interesting feature of this embryo is a rather thin-walled epithelial cyst with a few rounded out-pocketings,

found just outside the muscularis of the duodenum, a short distance from the pancreas (*Fig.* 23). The intestine near by presents a solid cylindrical outgrowth which extends to the muscularis, but does not penetrate it. Undoubtedly this was formerly connected with the cyst, although at present it is not directed towards it, and is not where the cyst approaches to the muscularis. It appears that after the stalk became detached, the growth of the intestine carried it along and changed its direction.

FIG. 23.—Section from a pig embryo of 20 mm. The loop of the duodenum is cut in two places. Midway between these is the cyst. The cyst comes in contact with the muscularis in the following sections. A, Pancreas; B. Portal vein; C, Superior mesenteric artery; D, Duodenum; E, Muscularis; F, Cyst; G, Muscularis; H, Duodenum; I, Diverticulum. (× 30.) (*After Lewis and Thyng, 'American Journal of Anatomy', 1907–08, vii, 508.*)

Fig. 24.—Enterogenous cysts: A, Submucosal; B, Intermuscular; C, Subperitoneal; D, Intramesenteric. ⫲ = Longitudinal muscular coat; ☰ = Circular muscular coat; ⌇ = Mucosa.

It is obvious, too, that the fully developed cyst may occupy any plane in the intestinal wall—submucosal, intermuscular, or subserous—and may occupy any segment of the gut periphery, whether antimesenteric, mesenteric, or any intervening site. Sometimes a subserous cyst situated on the mesenteric border of the gut loses its attachment to the gut wall and occupies a position between the layers of the mesentery more or less remote from the parent gut. (*Fig.* 24.)

From examination of histological sections it is apparent that cysts which at one time were subserous have become invaginated more or less completely into the lumen of the gut, may even have become pedunculated, carrying before them the coats of the gut. That this is the method of production of the case here reported is obvious

when we compare *Fig.* 25 with *Fig.* 18 and Sir Arthur Keith's histological report. Nearly all *reported cases of ileocæcal cysts belong to this type of developmental cyst.* (*See* case reported by Sir Arthur Keith[4] —R. C. S. Museum, Specimen No. 1220.01.)
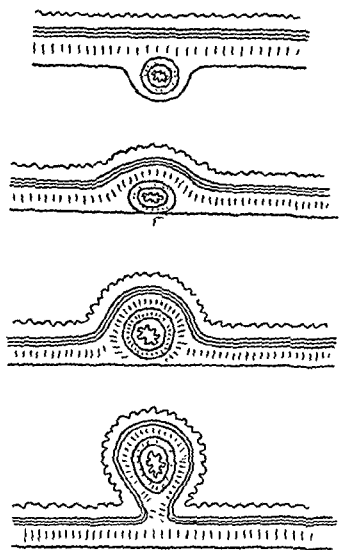
FIG. 25.—Diagram showing a subserous enterogenous cyst becoming invaginated into the lumen of the gut.

VARIATIONS IN THE STRUCTURE OF THE CYST LINING.

In a large number of recorded cases the structure of the cyst wall is complete, the mucosa, submucosa, and muscular layers being unmistakably intestinal. In others, however, there are great variations in the mucosal layer. We find " stratified epithelium ", " cylindrical epithelium of varying heights ", " a few epithelial cells ", " atrophic mucosa ", " tall columnar cells ", " a somewhat stretched layer of columnar epithelium ", " cubical epithelium with traces of submucosa ", " flattened epithelial cells ", " typical stratified epithelium with occasional cylindrical and cuboidal groups of cells ", " stratified ciliated cells ", " columnar ciliated epithelium ", " a single layer of cuboidal epithelial cells ", and even " the inner layer presents the structure of a serous membrane ". Occasionally we find several varieties represented in the same cyst (*see* Miller's, Studgaard's, Hedinger's, and Gfeller's cases). The formation of villi may be complete or incomplete.

Many of the changes found in the lining of the cyst cavities can be accounted for by intracystic tension or by inflammatory changes. Others may be explained by the embryological development of the gut. *Fig.* 26 shows a section of the gastric epithelium from an embryo of 22·8 mm., in which it is seen that in places the epithelium is clearly simple, but elsewhere it may show several rows of nuclei, and is perhaps stratified. In embryos of 5·5 and 7 mm. the duodenum usually presents a well-defined round lumen bounded by a two- to three-layered epithelium. In slightly older embryos the epithelium proliferates and vacuoles are formed within it. Later the proliferating epithelium bridges and subdivides the original lumen, as seen in the section of a 10-mm. embryo (*Fig.* 27 *A*).

FIG. 26.—A section of the gastric epithelium from an embryo of 22·8 mm. (× 330.) (*From Keibel and Mall,* ii, 372, *Fig.* 275.)

Occasionally the masses of cells surrounding the vacuoles produce local bulgings of the basement membrane. At 22·8 mm. (*Fig.* 27 *B*) the

out-pocketings are so numerous that the epithelium appears folded, and mesenchyma has begun to extend inwards between the pockets or folds. In sections the vacuoles cannot be distinguished from the main lumen. At 30 mm. (*Fig.* 27 *C*) the vacuoles begin to become confluent so that a central lumen is re-established. " The projections between the vacuoles remain as the foundations of villi." In embryos from 30 to 60 days the duodenal lumen is normally more or less completely obliterated.
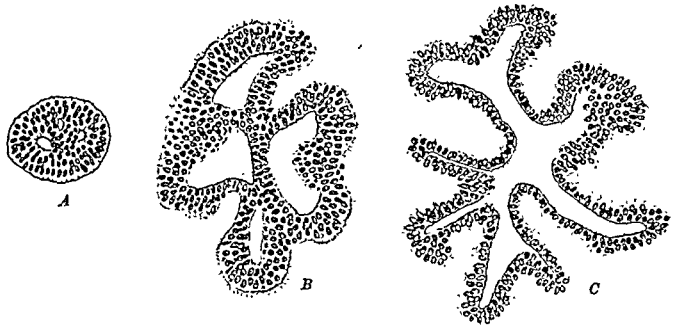
FIG. 27.—Cross-sections of duodenal epithelium. (× 85.) *A*, At 10 mm. The upper cavity is a vacuole, the two lower ones are part of the original lumen. *B*, At 22·8 mm. C, At 30 mm. (*From Keibel and Mall*, ii, 382.)

Kollman[5] states that the epithelium of the developing gut undergoes a regular progression from simple cuboidal to simple cylindrical, and then to stratified epithelium; from which finally develops the permanent layer of simple cylindrical epithelium, which in the respiratory tract is ciliated. To account for the diversity of cells found lining enterogenous cysts it has been suggested that the sequestered group of cells may retain the characteristics shown by its parent at the time of separation. This is a possibility; but a much more probable explanation of the varied types of epithelium found lining certain of these developmental cysts and diverticula is afforded by a study of the epithelial misplacements of the intestinal tract. We know that the cells lining the whole primitive intestinal canal are morphologically identical, and that later they become differentiated into the squamous epithelium of the œsophagus, the glandular elements of the stomach, duodenum, small and large intestine, the mucosa of the gall-bladder, and the parenchyma of the liver and pancreas. Nicholson[6] has shown that these fully differentiated cells may de-differentiate when chronically inflamed, and eventually re-differentiate into the cells typical for that particular region, gastric cells in the stomach, intestinal cells in the intestine, gall-bladder mucosa in the gall-bladder, etc. On the other hand, such de-differentiated cells may become re-differentiated, but in a direction other than that of the normal embryonic development. Thus, Nicholson reports the frequent occurrence of gastric glands in the mucosa of gall-bladders as a result of cholecystitis, and has described the presence of gastric glands in a tuberculous ulcer of the colon, and of newly-formed pyloric glands in tuberculous granulations of the vermiform appendix, the differentiation under these pathological stresses being atypical or heterotopic. Along the same lines Nicholson would explain the presence of developmental heterotopic tissues (cardiac glands in the œsophagus, intestinal glands in the stomach, squamous epithelium in the gall-bladder, squamous epithelium in a pancreatic duct, etc.), " since there is good evidence [Meyer[7]] that everyday pathological processes take place even in the embryo and these must surely alter the environment of the cells."

If, then, abnormal differentiation of cells occurs when the surrounding conditions are abnormal—in other words, when the environment is altered—it is not to be wondered at that the cells lining fœtal diverticula and cysts sometimes differentiate abnormally and give rise to the many varieties of epithelium which have been found lining these structures. We shall later refer to instances in regard to which little doubt can be entertained that heterotopic tissue has occurred in and been occasioned by developmental diverticula ; sufficient here to note the fact that in the normal processes of development when diverticula form from the primitive digestive tract, some subtle change takes place in the endoderm lining them, and lung or pancreas, liver or gall-bladder results.

DISTRIBUTION.

Although most of the congenital diverticula have been discovered in the duodenal region and most of the congenital intestinal cysts in the ileocæcal region, there is no reason why they—cysts and diverticula—should not develop in any part of the intestinal tract ; and a study of the literature reveals the fact that they do occur over a wide distribution : in the œsophagus, stomach, duodenum, jejunum, ileum, ileocæcal region, vitello-intestinal tract, vermiform appendix, and sigmoid.

J. W. Larimore and Graham[8] state that in 3446 cases of complete X-ray examinations of the intestinal tract they found diverticula in 105 cases : 9 of the œsophagus, 3 of the stomach, 19 of the duodenum, 3 of the jejunum, and 71 of the colon.

ŒSOPHAGUS.

R. G. Hebb[9] demonstrated a specimen which he had removed from a female, age 31, who died of heart disease at Westminster Hospital. The cyst, the size of a pigeon's egg, was attached to the œsophagus about an inch and a half below the left lobe of the thyroid body, lying in the angle between the œsophagus and the trachea, with the recurrent laryngeal nerve passing over it. There was no communication, and no naked-eye evidence of previous association with the œsophagus. Microscopical examination of the wall of the cyst shows that it is composed chiefly of muscular tissue, and that it is lined by a mucosa. The muscular tissue is striped and unstriped ; externally there is a layer of striped muscle, next
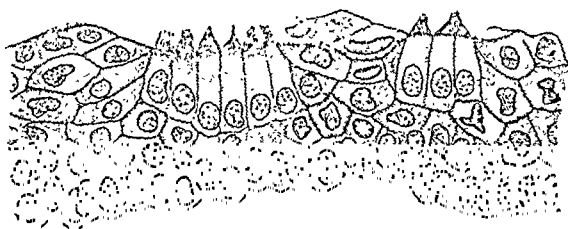
Fig. 28.—Section of the œsophageal epithelium of a negro child at birth, showing many ciliated cells. (× 600.) (*From Keibel and Mall,* ii, 361.)

to this a single layer of unstriped muscle, cut transversely, and next internally are several layers of unstriped muscle, the fibres being arranged parallel to their long axes and to the outline of the cyst. The mucosa consists of two to three layers of cells, the superficial ones being columnar ciliated epithelium. Compare with this a section made of the œsophagus of a negro child by Lewis[10] (*Fig.* 28).

Wyss[11] described a tumour found in the body of an adult. It was situated on the posterior aspect of the œsophagus, about one inch above the cardia, and was as big as a medium-sized apple. It contained a gelatinous, milky-coloured fluid, in which were many ciliated epithelial cells. The inner lining, 1 mm. thick, consisted of degenerated ciliated epithelial cells; the other layers consisted of connective tissue and muscular tissue.

See also Roth's case, p. 49 and *Fig. 37.*

STOMACH.

Gardiner[12] described a stomach, the posterior surface of which is seen in *Fig.* 29. The cardiac end was the size of a tennis ball, and its capacity was 56 c.c. The stomach then became constricted, and beyond the constriction the pyloric half of the stomach resembled a tube. In the furrow at the constriction was an accessory pancreas; the pancreas was continued through the posterior wall of the stomach and terminated in a papilla just below the lesser curvature. Opening off from the posterior wall of the pyloric tube was a large sacculation, like the dilated finger of a glove, lying parallel with the greater curvature of the stomach. The communication between the pyloric portion of the stomach and the diverticulum comfortably admitted the middle and index fingers. The main pancreas was found in its usual position and showed no anomalies.
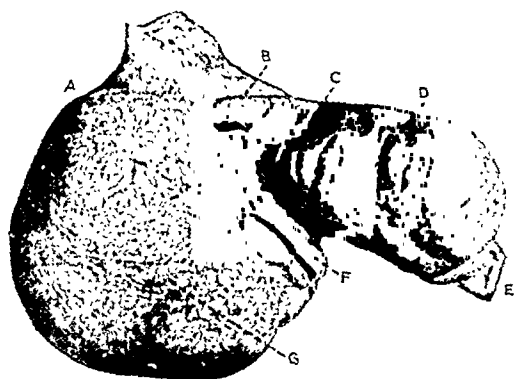
FIG. 29.—The posterior surface of the stomach, showing a large diverticulum of the pyloric portion, and an accessory pancreas. A, Cardia; B, Location on the mucous membrane of the papilla for the opening of the excretory ducts; C, Epiploic vessels; D, Diverticulum; E, Pylorus; F, Accessory pancreas; G, Fundus of stomach. (*From the 'Journal of the American Medical Association'*, 1907, xlix.)

A. W. Pritchard[13] operated on a boy, age 15, who from infancy had been subject to attacks of 'wind colic'. The attacks of abdominal pain and swelling had been occurring irregularly about every two months, sometimes with and sometimes without diarrhœa. For the ten days prior to the operation he had been kept in bed and suffered from six violent attacks with diarrhœa. The boy stated, "The lump comes up with pain that makes me groan; the lump goes, and then the pain passes off." "On opening the abdomen a huge mass was found pushing forward the transverse colon. It looked like a huge intussusception, or a hernia of the stomach between the layers of the mesocolon. In fact when I had incised the peritoneum over it, it was so like a stomach that I prolonged my skin incision to prove that the stomach was in its normal place. I opened the cyst and about 15 oz. of fluid were let out. I then proceeded to free it from its attachments. stripping off the peritoneum with considerable difficulty and hæmorrhage. A pedicle was found at the vertebral attachment and tied off." The specimen was shown at the Pathological Society of Great Britain and Ireland, and reported on thus: 'Microscopically the cyst wall was composed

of gastric mucosa. The glandular layer showed an excess of mucoid-forming cells, but otherwise the normal appearances were not departed from. The sub-mucous, muscular, and serous layers were all represented, and were typical.'"

Ahrens[14] reported an operation on a female 17 years old in whom he found and removed a cyst containing four litres of thick reddish-brown fluid. The cyst was situated behind the peritoneum on the right side of the abdomen. In appearance it suggested an hour-glass stomach and 26 cm. of small intestine. Microscopical examination of the cyst wall revealed a structure identical with that of a stomach and small intestine, save that the mucosa in different sections consisted of stratified and cuboidal cells, stratified ciliated cells, tall columnar, and flat cells. The fluid in the cyst was weakly acid, and digested egg albumen on the addition of hydrochloric acid. There were multiple ulcers in the pseudo-stomach.

Fig. 30 is a drawing from a specimen in the Westminster Hospital Museum (No. 455.A). In the pyloric portion of the stomach immediately
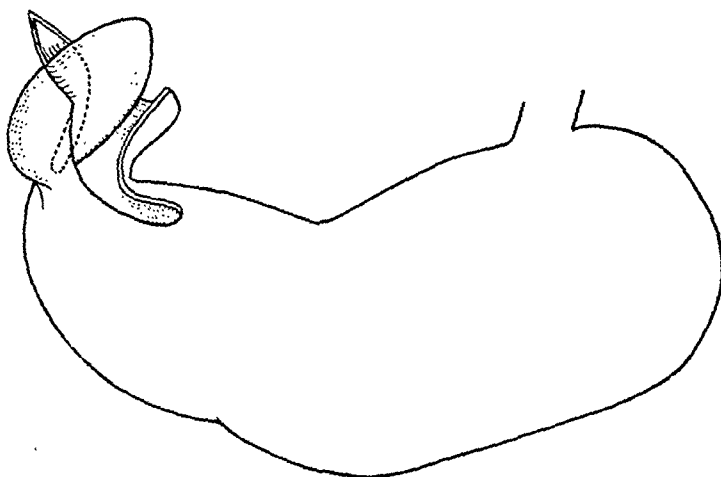
FIG. 30.—Developmental enterogenous cyst in the pyloric end of the stomach, immediately adjacent to the pylorus. (*Westminster Hospital Museum*, No. 455.A.)

adjacent to the pylorus is a firm-walled cyst 2 × 1 in. The reflection of the gastric mucosa on to the anterior and outer surface of the cyst is shown in the drawing; elsewhere the attachment of the tumour is indicated by the dotted line. "The stomach is not dilated, nor is the pylorus distorted, showing that no obstruction was caused. From a child 6 months old, who died from perforation of a typhoid ulcer in the ileum. The cyst contained glairy fluid." A recently cut section of the cyst wall where it protrudes into the lumen of the viscus shows it to be covered by pyloric mucosa; this lies upon a muscular coat. The cyst is lined by "flattened gland cells".

There is in the Royal College of Surgeons Museum a pedunculated diverticulum $2\frac{3}{4} \times 1\frac{1}{2}$ in.; its wall is $\frac{1}{5}$ in. thick, and the lining mucous membrane exhibits rugæ resembling those of a normal stomach. Microscopical examination of the wall of the diverticulum shows the general structure of a stomach. The central canal in the pedicle is lined by a mucosa consisting of short glands which are mucus-secreting throughout their length;
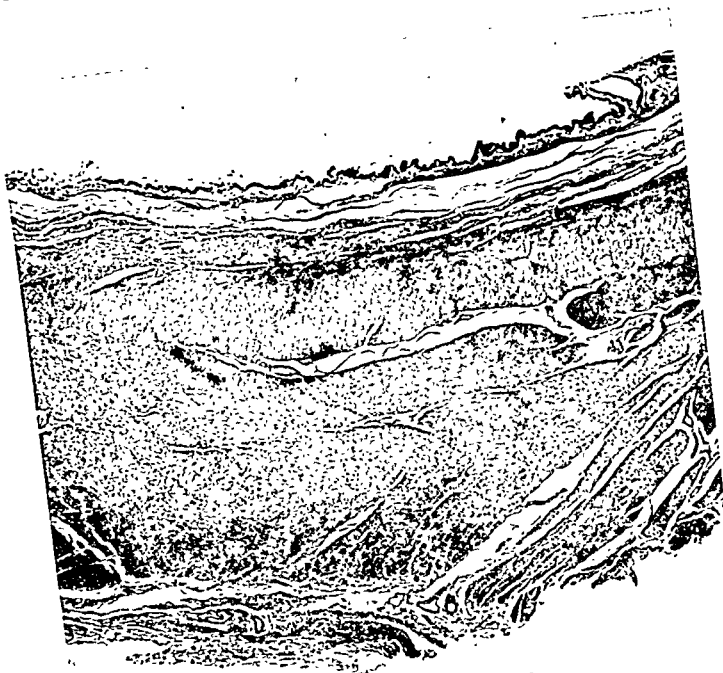
× 15
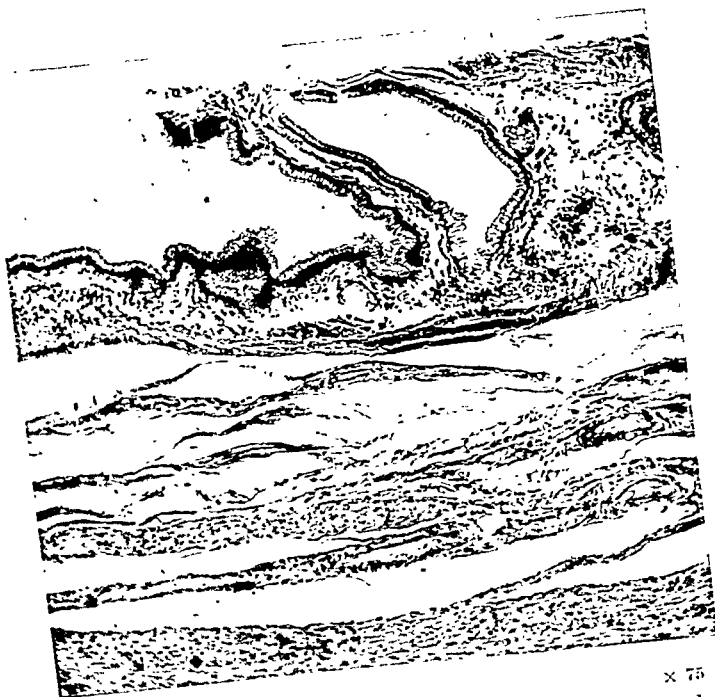
× 75

FIGS. 31, 32.—Sections of developmental enterogenous cyst, enucleated from the wall of the stomach and from the adjacent pancreas. (*Westminster Hospital Clinical Reports*, 20–1116; Section No. 3884.A.)

the submucous layer is only slightly marked, and a muscularis mucosæ not recognizable ; there are two layers of muscle ; outside these is a broad layer of dense and highly muscular connective tissue. This diverticulum was removed by Mr. Neil Sinclair from a child 4 months old. It lay in the angle formed by the duodenum and jejunum. The pedicle was directed upwards across the anterior surface of the termination of the duodenum ; it passed through a hole in the transverse mesocolon, and around this aperture the mesocolon was much thickened. The diverticulum contained blood and mucus. There was no torsion of the pedicle.

Figs. 31 and 32 show low- and high-power views of a section through the wall of a cyst removed by Mr. Rock Carling. The patient was a female, age 39. The cyst, the size of a walnut, was embedded partly in the pancreatic substance and partly in the muscular wall of the stomach. To remove it, it was necessary to incise the muscular wall of the stomach on the upper aspect of the cyst. The cyst contained a few minims of turbid fluid. It possessed a fibromuscular coat 4 mm. thick, and was lined by tall columnar mucus-secreting cells, by low cuboidal cells, and by flattened cells.

DUODENUM.

Many instances of congenital intestinal diverticula of the duodenum have been recorded, particularly in the second portion. Now that screen examinations after a bismuth meal are so constantly made, duodenal diverticula have ceased to be looked upon as great rarities.

Spriggs[15] found that the situation of the diverticula in the reported cases of Buschi, Bauer, Wilkie, Bosch, Ritchie, and McWhorter was as follows :

Out of 57 cases : 11 in the first part ; 2 in the first and second parts ; 41 in the second part ; and 3 in the third part of the duodenum.

C. M. Jackson[16] reported a case of duodenal diverticulum which was found post mortem in a man, age 50, who had died of pneumonia. " It extends upwards from the upper wall of the transverse duodenum (*Fig.* 33). The sac measures about 3·5 cm. in the vertical direction, 3 cm. in the transverse width, and 2 cm. antero-posteriorly (being deepest in this direction in the lower part of the sac). The neck of the sac is constricted, the aperture of communication with the duodenum measuring about 5 mm. in diameter. The diverticulum is in contact, posteriorly, with the aorta and vena cava.
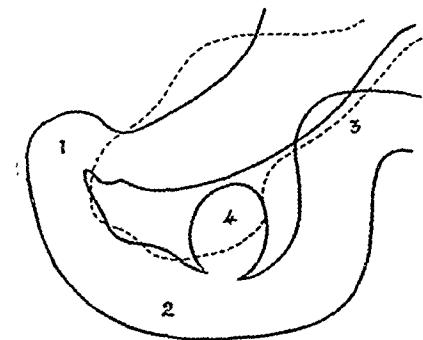
FIG. 33. — Diverticulum of the duodenum. 1, First part of duodenum ; 2, Transverse duodenum ; 3, Duodenojejunal angle ; 4, Duodenal diverticulum. Pancreas is shown in dotted outline. (*After Jackson, 'Journal of Anatomy and Physiology'*, 1902, xlii, 219.)

Anteriorly, it is in contact with the superior mesenteric artery and vein *below*, and with the posterior surface of the head of the pancreas *above*. The wall of the sac is thin (0·7 to 0·8 mm.), and in general resembles the neighbouring duodenum in structure. It is lined by mucous membrane, somewhat reduced in thickness, and is limited externally by a thin fibrous tunic. Between *these*

is a muscular coat, only 0·1 to 0·15 mm. in thickness, but everywhere distinct."
Fig. 33 should be compared with *Fig.* 22—a drawing by Lewis and Thyng of a duodenal diverticulum in a 13·6 mm. embryo.

Specimen No. 6283.1, Royal College of Surgeons Museum, shows two diverticula of the duodenum (*Fig.* 34). Imme-
diately adjacent to the bile papilla is a round aperture in the wall of the bowel, measuring about half an inch in diameter, and leading into a diver-
ticulum of somewhat pyriform shape, and $1\frac{3}{4}$ in. long. The wall of the pouch consists of the mucous and submucous coats of the bowel. On the oppo-
site side of the bile papilla is a small aperture leading into a pouch the size of a pea. The patient, a man, age 72, died of a strangu-
lated hernia. There were several small diverticula in various parts of the small intestine.

In the Westminster Hospital Museum No. 455B is a large diverticulum of the first part of the duo-
denum. Its vertical diam-
eter is $1\frac{3}{4}$ in., its transverse diameter $1\frac{1}{4}$ in., and its
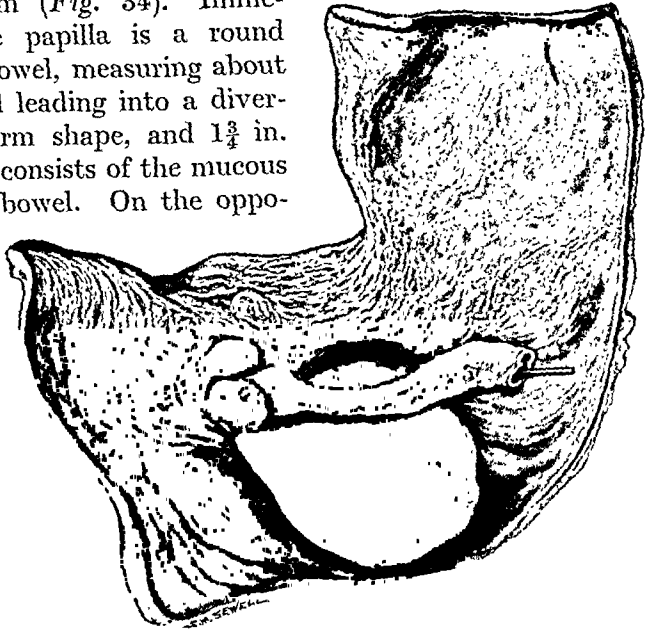
FIG. 34.—Two diverticula of the duodenum, the open-
ings into which are situated one on each side of the bile papilla and immediately adjacent to it. (*R.C.S. Museum, No.* 6283.1.)

depth about 1 in. Microscopically the lining of the diverticulum was found to be normal mucosa, and the muscular coats were hypertrophied (*Fig.* 35).

FIG. 35.—Section through the wall of a duo-
denal diverticulum, showing a normal mucosa, and hypertrophied muscular coats. (*Westminster Hospital Museum, No.* 455B. *Section No.* 199.)

Roth[17] records a case occur-
ring in a newly-born male child who lived but a few minutes; the abdomen was greatly distended; there was a large thin-walled cystic tumour, lying on the stomach and duodenum; in the illustration the tumour is shown displaced downwards (*Fig.* 36). It will be noticed that the tumour is in two parts, A and B. The two sacs were quite separate, but they had a common pedicle in the region of the pancreas and the duodenum. Dissection of this region revealed a short pipe-like connection 1 cm. long between the two cysts. This intercommunicating channel was lined by cylindrical epithelium of varying heights. No connection was discovered between the cysts and the lumen of

the intestinal canal, but at the posterior surface of the pedicle was a layer of unstriped muscle which was thought to have been torn from the wall of the duodenum.   Sections of the cyst wall revealed all the layers of the intestinal wall ; in places the mucosa was thin.   c is an enterogenous cyst in the right posterior mediastinum, situated close to the œsophagus, and evidently derived from it.   Its wall had a structure closely resembling that of gut, save that the cells of the mucosa were flattened from intracystic pressure.
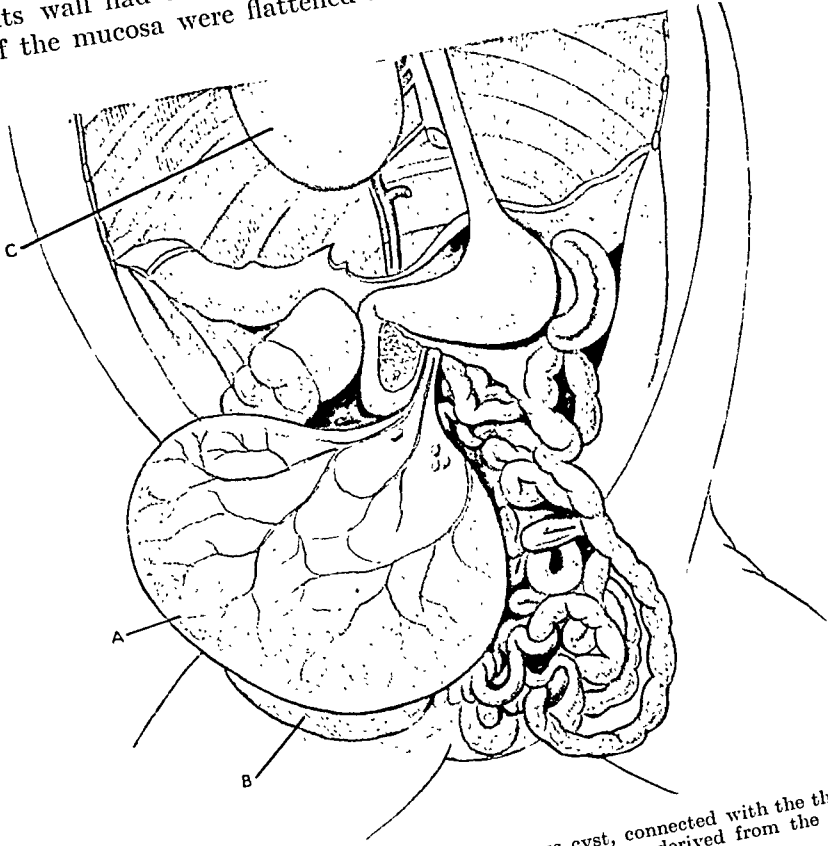
FIG. 36.—A and B, Developmental enterogenous cyst, connected with the third portion of the duodenum.   C, Cyst in right posterior mediastinum, derived from the œsophagus.
(After 'Virchow's Archiv', lxxxvi, Taf. xv.)

Oliver Waugh[18] reported a cyst connected with the second portion of the duodenum, found at an operation for persistent vomiting in a child 19 days old.   The cyst, the size of a tangerine orange, was retroperitoneal, and was intimately connected with the posterior wall of the second portion of the duodenum.   The gut being tightly stretched over the cyst had occasioned the obstructive symptoms.   The cyst wall possessed well-marked inner circular and outer longitudinal muscular coats.   I think there can be no doubt that the case, like Roth's, is a developmental enterogenous cyst, derived from the second part of the duodenum.

Sanger and Klopp[19] described the condition found in the abdomen of a newborn child (Fig. 37).   The labour was very difficult and protracted, and

the child died before the delivery was completed. The viscera were trans-posed. The heart occupied the right side of the chest. The stomach was situated in the right upper abdomen. The liver filled the left hypochondrium. " Instead of the spleen, in the right hypochondrium were 16 completely isolated lobules of spleen tissue—together forming a mass equal to that of the normal spleen." 'The abdomen contained five cysts—their situation being
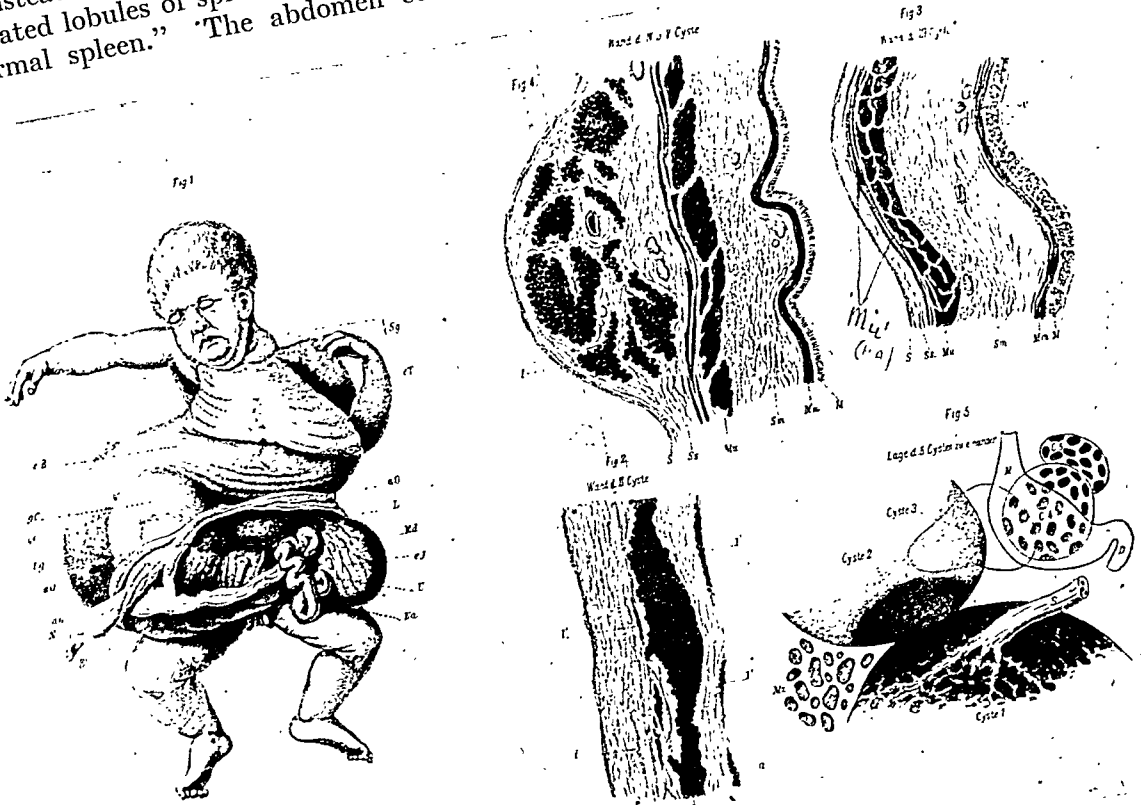
FIG. 37.—Abdomen of a new-born child in which there were five developmental enterogenous cysts. The walls of these contained liver substance.

Fig. 1.—General appearance of the child after opening the abdomen. gC and gC', The largest of the cysts; Lg, Scattered nodules of liver substance; L, Right lobe of liver, in the left hypochondrium; Bl, Bladder; N, Umbilical cord; U, Urachus.

Figs. 2, 3, 4.—Sections of the various cyst walls. M, Mucosa; Mm, Muscularis mucosæ; Sm, Submucosa; Mu, Muscular coats; l, l', Liver substance; i, Connective tissue.

Fig. 5.—Relation of the five cysts to each other. Mz, Lobules of spleen.

(From 'Archiv f. Gynäkologie', 1880, xvi, 415, Taf. vii.)

shown in Fig. 37 [Fig. 5]. The largest cyst was the size of the child's head; its circumference was 30·5 cm. The anterior surface of this cyst over an area about 7 cm. in transverse diameter was composed of a thin layer of a dark brown substance 1·5 to 2 mm. thick. This substance looked like liver, and microscopical examination proved it to be so. For some distance from the main mass of liver substance small

isolated masses could be seen accompanying the vessels which ran in the wall of the cyst. The pedicle of the cyst was attached about the centre of the mass of liver substance, and this pedicle ran upwards towards the duodenum. I regret that the exact attachments of this pedicle are not described. The cyst contained about 300 c.c. of dark yellow mucoid fluid in which bile was present. When microscoped the fluid was found to contain flattened cells and low cubical epithelial cells. The wall of the cyst consists of an outer peritoneal surface lined by closely interwoven connective-tissue fibres and some compressed and atrophied unstriped muscle fibres. Immediately above this cyst was a second, 23 cm. in circumference. These were adherent to one another over an area the size of a shilling piece—but there was no communication between the two cavities. The whole surface of this second cyst was covered by a layer of liver tissue, thickest where the two cysts were opposed. The structure of its wall is shown in *Fig.* 37 [Fig. 4], in which it will be seen that a layer of liver structure lies between the inner and outer connective-tissue planes. On following the pedicle of the first cyst towards the duodenum a third cyst was found, a little bigger than a walnut. The wall of the cyst was 1½ mm. thick, and its structure was identical with that of the intestinal wall, as shown in *Fig.* 37 [Fig. 3] : a mucosa possessing no Lieberkühn's glands, a well-developed muscularis mucosæ, a submucosa, then a well-developed circular muscular layer, a longitudinal muscular layer, subserous layer, and peritoneum. Above this and connected with it, and behind the stomach, was a fourth cyst, smaller than the third. Its outer surface was covered with tiny masses of liver substance of varying thickness. The structure of the wall (*Fig.* 37) [Fig. 4] is identical with that of gut, but there are islets of liver tissue in the subserosa. Above this cyst is a fifth, which macroscopically and microscopically is identical with the cyst last described.

Sanger and Klopp came to the conclusion that the first cyst was developed from an accessory liver, and that the primitive gall-bladder had undergone a cystic degeneration ; that the second cyst must have been developed from the bile-duct of the accessory liver, and that this also had undergone cystic degeneration ; and that cysts 3, 4, and 5 were intestinal cysts. That these are enterogenous cysts there can be no doubt. The occurrence of liver cells in their walls is of great interest, and I have come across no other cyst of intestinal origin showing this structure. Seeing, however, the fairly common occurrence of pancreatic tissue in diverticula, it was only to be expected that liver substance would be found in enterogenous diverticula and cysts ; for with our knowledge of the heteromorphoses of the intestinal tract, it is not surprising that the cells lining diverticula of the fœtal entoderm in the vicinity of those buds which grow out and form the liver should themselves display the same power and differentiate into liver cells. Although the structure of cysts 1 and 2 only *incompletely approximate* to that of the intestinal wall, still the presence of a serosa, connective tissue, compressed muscle fibres, and the occurrence of shed epithelial cells (flattened and cubical) in the fluid contents of the cysts, is sufficient justification for the assumption that these too belong to the group of developmental enterogenous cysts.

JEJUNUM.

William Major,[20] under the heading " Constriction of the Jejunum by a Congenital Prolongation of its Coats ", describes a case of intestinal obstruction in a pregnant woman, age 37. The site of obstruction was between three and four inches from the duodenojejunal flexure. At this point a diverticulum arose from the anterior surface of the jejunum, encircled the gut, and formed a knot which could not be untied.

Helverstine[21] found at a post-mortem on a male, age 70, who died of uræmia consequent on hypertrophy of the prostate, 58 diverticula in the first 95 cm. of the jejunum. These varied in size from 2·5 × 2 cm. to 0·5 × 0·3 cm. They were all situated along the mesenteric border of the jejunum. The large diverticula were near the duodenum, and diminished in size as the distance from the duodenum increased. Helverstine gives a summary of 27 cases of diverticula of the jejunum reported in the literature. Commenting on the condition he says : " Such diverticula in the beginning of their formation are of the true type, containing all the coats of the intestinal wall, as in the case of the smallest pockets found in my specimen and in the specimen described by Klebs.[22] Later, due to progressive atrophy, now accelerated by increased pressure from within, the muscle fibres disappear and a large diverticulum of the false type is found."

Braithwaite[23] and J. Allan Berry[24] have reported cases of multiple diverticula of the jejunum. Braithwaite's specimen is in the R.C.S. Museum (No. 6377.1).

Buchwald[25] reported a case in which he found two cystic tumours, one 10 cm. long, the other 17 cm. long, 4 cm. apart, arising from the jejunum about 50 cm. from the duodenum ; these communicated with the gut by a small opening. Microscopical examination showed the diverticula lined by atrophic mucosa ; the walls consisted mainly of connective and fibrous tissue, with a few muscular fibres.

John L. Hunter[26] described a cyst found in a child who died when seven days old. Lying along the mesenteric border of the jejunum and between the two layers of the mesentery were two cystic swellings. The jejunum was stretched transversely upon these swellings so that its lumen was slit-like in cross-section. The cysts were found to communicate with one another at the intestinal border of the mesentery by an opening 1 cm. in diameter. One loculus measured 55 × 43 mm., the other 68 × 41 mm. The walls contained all the elements found in the wall of the intestine, but the most careful dissection showed no communication between the lumen of the cysts and that of the intestine.

Robert T. Miller[27] reported a case of intestinal obstruction due to an enterogenous mesenteric cyst causing volvulus in a female child operated upon when four days old. On the mesenteric side of the jejunum, about 12 cm. from the pylorus, was a cystic tumour, measuring 4 cm. in its long axis and 3 cm. in its transverse axis. The cyst lay between the layers of the mesentery, intimately connected with the jejunal wall ; for a distance of 4·5 cm. the bowel was greatly compressed by the subjacent mass, being flattened out into a ribbon-like band 1·5 cm. across at its widest point. The

cyst was lined by a single layer of columnar cells; over the greater portion of the cyst wall these were thrown up into well-developed villi. The villi were of their maximum size in the region most remote from the gut, gradually diminishing in height and number as the gut was approached; at the same time the epithelial cells diminished in height, becoming low columnar, then cuboidal, and finally over that portion subjacent to the lumen of the bowel the epithelium was quite flattened out. Below this layer was a submucosa, then two well-developed muscle layers, arranged at right angles to one another. As the bowel was approached, the inner muscle layer split into two portions and became continuous with the inner circular muscle layer of the jejunum. The external layer of muscle in the cyst wall remained intact and was directly continuous with the external longitudinal muscle of the bowel, thus forming a muscular envelope common to them both. We have here, then, an intermuscular enterogenous cyst, projecting between the layers of the mesentery.

Norman Moore[28] reported the following case : " The intestines of a man, age 40, showing three diverticula in the first three feet of the small intestine, and a congenital stricture at the commencement of the jejunum. The diverticula are each an inch long and about as much in diameter, and are on the mesenteric side of the intestine. Their walls consisted of all the intestinal coats and they were not mere hernial protrusions."

Von Puschmann[29] found in the abdomen of a boy, age 6, who had died from general peritonitis, a cyst attached to the jejunum 25 cm. from the duodeno-jejunal flexure (*Fig.* 38). The cyst was situated on the mesenteric aspect of the gut. It was bilocular; the larger division is described as being as big as ' a man's fist ', the smaller the size of ' an apple ' ! The larger division was situated in front of the mesentery, the smaller was post-mesenteric. The cyst was attached to the gut over an area the size of a ' 5 shilling coin ' ! A part of this attachment had been torn, with the result that there was a hole in the cyst and another in the adjacent portion of jejunum. Through this hole fæces had escaped into the general peritoneal cavity, resulting in the death of the patient. The structure of the cyst wall resembled that of gut, and the two layers of muscle were found to be continuous with the corresponding layers of the adjacent jejunum.

Fig. 38.—Bilocular developmental enterogenous cyst attached to the jejunum. (*From 'Deutsche Zeitschrift für Chirurgie'*, 1904, 109.)

ILEUM.

Roth[17] reported a case of a diverticulum situated 66 cm. from the ileocæcal valve. It was attached to the mesenteric border of the ileum by a pedicle 11 mm. long, through which it communicated with the lumen of the gut (*Fig.* 39). The wall showed the structure of normal intestine. This case was presumably a Meckel's diverticulum.

FIG. 39.—Diverticulum of the ileum. (*After 'Virchow's Archiv'*, lxxxvi, *Taf.* xv, *Fig.* 1.)

Tiedemann[30] found a similar cyst in a full-term fœtus. It was pear-shaped, pedunculate, and attached to the convexity of the intestine. It was $14\frac{1}{2}$ lines long and 7 lines wide. Its cavity communicated with that of the intestine by means of a canal in the pedicle large enough to admit a probe.
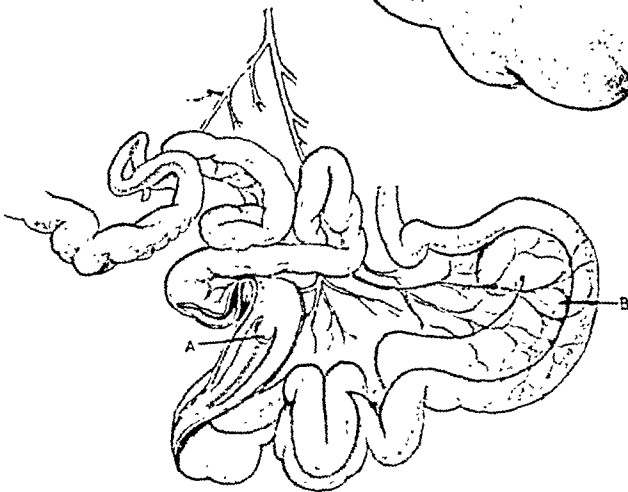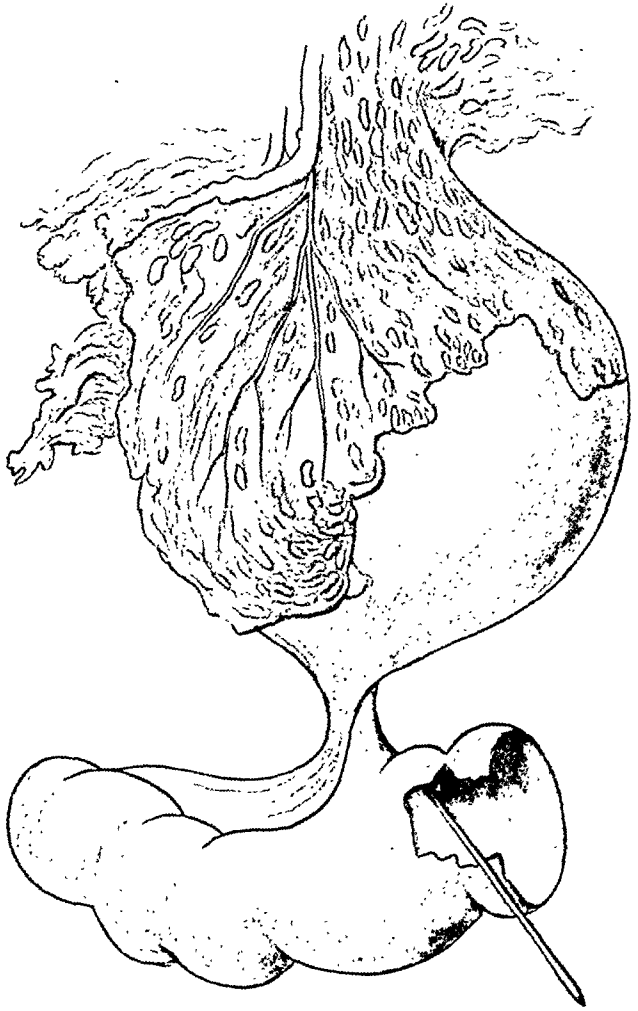
FIG. 40.—Developmental diverticulum of the ileum, situated between the layers of the mesentery. A, Mouth of diverticulum; B, Diverticulum. (*After 'Virchow's Archiv'*, lxxxvi, *Taf.* xv, *Fig.* 3.)

Roth[17] reported another case in which a cystic tumour 10 cm. long was situated between the layers of the mesentery of the ileum. The opening into the gut was situated 14·5 cm. above the ileocæcal valve (*Fig.* 40). Section of the tumour wall showed all the structures of the intestinal wall, with cylindrical epithelium, goblet

cells, villi, Lieberkühn's glands, Peyer's patches, a well-developed muscularis mucosæ, submucosa, two layers of muscular fibres, and peritoneum. This case is of 'interest, in that the cylindrical epithelium lining the cyst was ciliated. At the distal end of this intramesenteric diverticulum, a cyst was seen the size of a bean, also lying within the mesentery. The structure of the wall was similar to that of the intestine. The epithelial lining was composed of cylindrical cells, some with and some without cilia. In this subject were also found a gut-lined cyst connected with the œsophagus, and another connected with the 3rd portion of the duodenum (see Fig. 36).

Hilton Fagge[31] says : " One of the preparations in our Museum is a specimen of a diverticulum distinctly stated to have been situated above the middle of the ileum. This diverticulum is as large as a hen's egg, and has an unusually rounded form, but it appears to possess all the intestinal coats.

F. van der Bogert,[32] in a female child, age 5 years, found a large cyst about 18 cm. in its longest diameter, two somewhat smaller cysts (containing about 1·5 litres of fluid), and ten small cysts. " All the cysts had their origin in the mesentery of the ileum. There was no well-defined pedicle, the attachment being in the mesentery and extending along the intestine for a space of about 12 cm." " Under the microscope the outer surface was seen to be covered with normal peritoneum. The subserous tissue contained many congested blood-vessels. Beneath the connective tissue were found many smooth muscle fibres arranged in bundles and forming two distinct layers running at right angles to each other, the arrangement being characteristic of the structure of the intestines. No epithelial lining was detected."

Hennig[33] reported the case of an abdominal cyst the size of a moderately filled adult stomach. It occurred in a newborn child, and filled the anterior part of the abdomen. The sac measured $8\frac{1}{2} \times 5\frac{1}{2} \times 4$ in., lay within the mesentery, and did not communicate with the intestine. It held 100 grm. of clear, pale red, somewhat viscid, slimy fluid ; its inner wall contained intestinal glands, and was covered with cylindrical epithelium.

Shallow[34] reported a case of entero-mesenteric cyst occurring in a child 5 months old, with a greatly distended abdomen, in whom a provisional diagnosis of Hirschsprung's disease was made. On opening the abdomen a cyst was found which was in direct contact with the small intestine, and extended from four inches from the ileocæcal valve for a length of 40 cm. ; 1500 c.c. of clear amber-coloured fluid were evacuated from the cyst, and the cyst with the adjacent portion of small intestine was removed. There was no communication between the cyst and the lumen of the gut. Section of the wall showed three coats of non-striated muscle, an outer longitudinal, a middle circular, and an inner longitudinal. It was lined in parts by columnar epithelium. The epithelial lining was not constant, but in places the columnar cells were several layers thick, and some of the cells ' appeared to be ciliated '.

Strode and Fennel[35] report a case in a child operated upon when four days old for intestinal obstruction. A tumour was found in the lower ileum, in size about 1·5 × 1 cm., causing the anterior surface of the ileum to protrude, about 6 cm. proximal to the ileocæcal junction. The gut distal to the cyst was collapsed, and distended above it. An incision was made into the wall of the ileum and the cyst was shelled out. It was then found that

another cyst completely occluded the lumen of the intestine, dilating it to a diameter of about 3 cm. This portion of gut was excised. The small cyst was " lined by papillomatous and flattened squamous epithelium, and had a muscular wall continuous with the musculature of the intestine." We have, in this interesting case, two cysts of intestinal origin, one intermuscular and the other within the lumen of the gut (analogous to those cysts which, moving centrifugally, ultimately become intramesenteric).

Eve[36] described two mesenteric cysts. One occurred in a child, age 11 weeks, in whom an abdominal tumour could be felt (the size of a small kidney). It could be freely moved all over the abdominal cavity. The swelling could be felt per rectum. A cyst the size of a tangerine orange was found between the layers of the mesentery of the small intestine (*Fig.* 41). Two ounces of fluid were aspirated from the cyst, the aperture was closed, and the cyst sutured into the wound. A week later the cyst was incised, washed
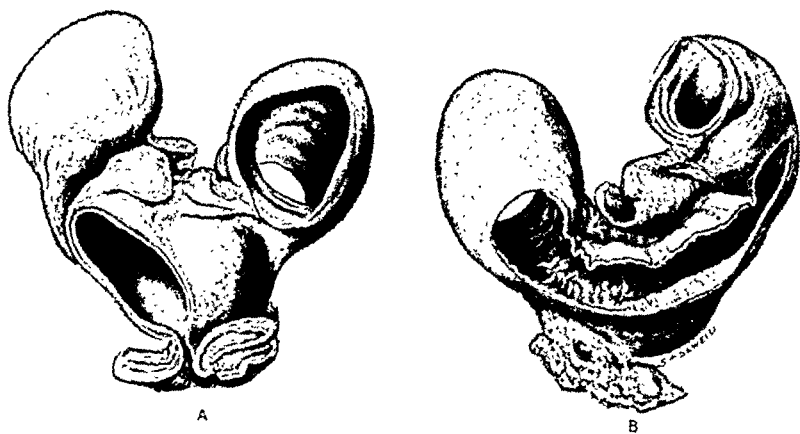
Fig. 41.—Mesenteric cyst. A shows the cyst and its attachment by operation to the abdominal wall; B shows the diminution in size of the lumen of the ileum produced by the cyst. ('*Med.-Chir. Trans.*' 1897–8. Specimen No. 1220.1, *R.C.S. Museum.*)

out, and a drainage tube inserted. A month later the child died following convulsions. When microscoped, no endothelial or epithelial lining was found, but just beneath the surface a thin layer of unstriped muscle cut longitudinally was seen, then a thick layer of muscle divided transversely, followed by another thick layer composed of several fasciculi running parallel to the surface. From this structure it can safely be assumed that we have here a developmental enterogenous cyst.

Since writing the above I have been examining Eve's specimen in the Royal College of Surgeons Museum, and was shown a microscopical section of the wall of this cyst which was made by Mr. Shattock when the specimens were being re-arranged. From an examination of this section (*Fig.* 42) it will be seen that my assumption that this was a developmental enterogenous cyst is justified: for although my diagnosis was founded on the original description of the muscular layers in the wall of the cyst, Mr. Shattock's section reveals a mucosal lining having intestinal characters, and places the cyst without any doubt in the category of enterogenous cysts. The case is thus described by Mr. Shattock: " The wall of the cyst is comparatively

thick, and, beneath its lining membrane, consists of a well-developed layer of tawny muscle fibre. Microscopic sections show that the wall is furnished with a double layer of unstriped muscle fibre, and in certain spots with a mucosa having intestinal characters, i.e., provided with crypts embedded in lymphatic tissue. Beyond the areas referred to, the mucosa becomes thinner and thinner, the crypts being much more and more oblique, as if from pressure, till the proper structure ceases to be recognizable. The calibre of the bowel is considerably reduced by the pressure of the swelling. The cyst is probably a fœtal diverticulum of the intestine of which the original communication has become closed."

Wallman[37] reports the following specimen in the Joseph's Akademie, Vienna. One piece of small intestine, 48 cm. long, contained thirty-seven diverticula varying in size from a pigeon's egg to that of a bean. Of these, thirty lay between the layers of the mesentery. Many of them were in the closest possible apposition to one another.

Studsgaard[38] described a cyst which he found in the mesentery of a girl 14 years old. The abdomen had been distended for years, and had been tapped on two occasions, three and ten years previously. The anterior layer of the mesentery over the tumour was incised, the cyst wall was punctured, and 2000 c.c. of chocolate-coloured fluid withdrawn. The cyst was enucleated, difficulty being experienced in the region of the pedicle, which was a funnel-shaped prolongation of the cyst towards the spine. This was ligatured, cut across, and the stump cauterized. "The cyst wall was in perfect agreement with the wall of the intestine."

Terrier and Lecène[39] reported an example, found post mortem, which was situated in the mesentery of the small

FIG. 42.—Microscopical section of Eve's mesenteric cyst, showing a mucosal lining and two layers of unstriped muscle fibres.

intestine, 50 cm. above the ileocæcal valve. Its walls contained muscular fibres, and it was lined by columnar epithelium. These authors in their

valuable communication suggest for the type of cyst we are considering, and which on section shows the structure of the intestinal wall, the name 'enteroides'.

Gfeller[40] operated on a female child, 11 years of age, for intestinal obstruction. He found one coil of small intestine had undergone rotation
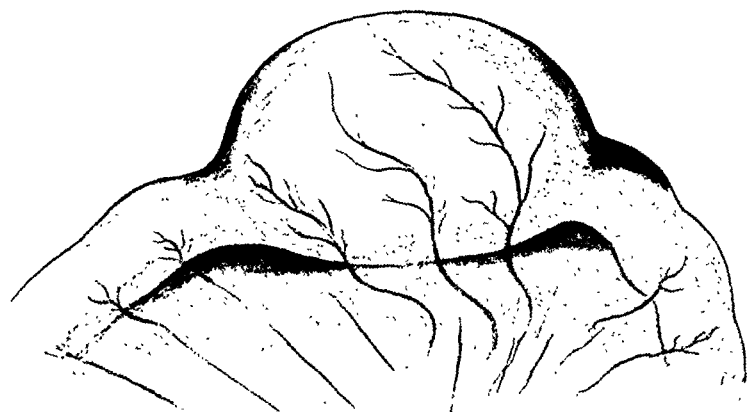
Fig. 43.—Enterogenous cyst situated in the ileum, producing volvulus and intestinal obstruction. (*After Gfeller, 'Deutsche Zeitschrift für Chirurgie'*, 1902, 330.)

through 360°. On following the dilated portion a tumour the size of an orange was found in the pelvis. It was situated on the antimesenteric border of the bowel, and seemed part of it (*Fig. 43*). On delivering the
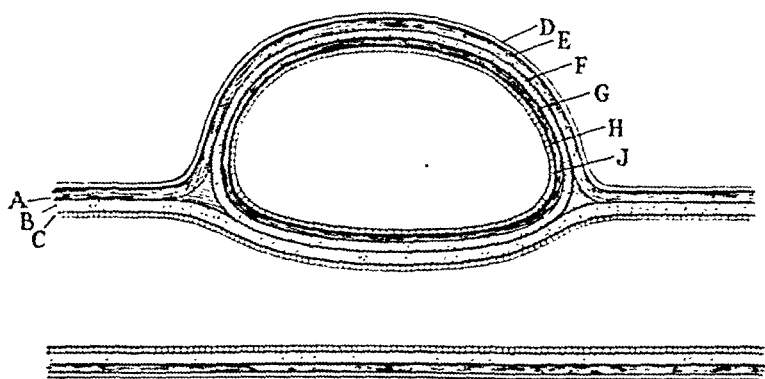
Fig. 44.—Longitudinal section through the tumour and intestine shown in *Fig. 43*. The enterogenous cyst is seen to be intermuscular. A, Long muscle ; B, Circular muscle ; C, Mucosa ; D, E, F, G, Serous. subserous, longitudinal, and oblique muscular fibres ; H, Muscular fibres, partly oblique and partly longitudinal ; J, Mucosa. (*After Gfeller, 'Deutsche Zeitschrift für Chirurgie'*, 1902, 330.)

intestine the volvulus was easily untwisted and the contents of the dilated part passed easily along the lumen of the bowel into the distal contracted loops. The tumour was 7·8 cm. long. cystic, unilocular, covered with peritoneum and with the longitudinal muscle of the bowel (*Fig. 44*). These

were divided and the tumour easily shelled out by peeling the longitudinal muscle from it, and by separating it from the circular muscle fibres. It had no connection with the lumen of the intestine. The wall of the cyst was composed of three layers of unstriped muscle ; the epithelial lining consisted in greater part of stratified epithelium, with occasional groups of cylindrical and of cuboidal cells.

Frankel's[41] case was found in a female child who died at the age of 3 days from intestinal obstruction. There was a globular swelling 2·5 cm. in diameter at the end of the ileum, between the muscular coats of the gut. Histological sections were not made till thirty years afterwards ; the walls of the cyst were found to contain muscular fibres, but there was no discoverable mucosa. It would be difficult to describe a case more graphically and in fewer words than those in which Gfeller summarizes this one : " Intestinal obstruction ; fæcal vomiting ; energetically purged ; death."

Seligmann's[42] case was 6 cm. from the ileocæcal valve. The structure of the cyst wall was similar to that of the intestine, and the cyst was situated in the muscularis mucosæ.

Dittrich[43] reported one case 30 cm., and another 60 cm., from the ileocæcal valve. In the first case the histological section was similar to that of small intestine, including Lieberkühn's glands. In the second the cyst wall presented the structure of small intestine, but was thinner ; the outer muscular layer was directly continuous with that of the gut.

Kulenkampff[44] records a case in a patient, 3 years old, who died of intestinal obstruction from torsion of the small intestine. There was seated in the mesentery, 40 cm. from the ileocæcal valve, a cystic tumour the size of a man's fist. There was no communication with the bowel. Kulenkampff states that the case was of the same nature as Roth's.

Nasse[45] reports a cyst in the small intestine the size of an egg, 80 cm. from the cæcum. It projected into the mesentery and into the lumen of the gut, which was completely interrupted, ending blindly proximally and distally to the cyst. The cyst was lined with tall columnar epithelium ; there were several goblet cells.

Tiedmann's[46] case (1813), referred to by Roth, was a pear-shaped cyst situated at the umbilicus and attached by a long pedicle to the convex border of the intestine. There can be little doubt that this was a Meckel's diverticulum.

Quesnel[47] reported four cases. The first was found in a newborn child. This was a cyst 3 cm. long in the submucosa on the antimesenteric wall of the ileum, near the cæcum. There was no communication with the gut lumen. Section showed two layers of muscle, and an atrophied mucosa with here and there columnar epithelium and glands. In his second case, a female child 4 months old who died of pneumonia, there was a similar cyst of the same size, near the cæcum, not communicating with the gut lumen. The wall showed on section a mucosa with columnar and goblet cells, glands, and two layers of muscle. His third case occurred in a female, age 62, who was operated upon for intestinal obstruction. The cyst was situated between the two muscular coats of the ileum in the antimesenteric wall, 57 cm. above the ileocæcal valve. It was composed of two parts, a smaller portion towards

the bowel lumen. and a larger cystic portion away from the lumen. The solid portion showed the structure of a spindle-celled sarcoma. Quesnel's fourth case is peculiarly interesting in that the mucosa of both cyst and adjoining intestine was tuberculous. The cyst, which showed the structure of the small intestine, was quite shut off from the lumen of the gut.

Hedinger,[48] in a post-mortem on a boy 5 years old, found a cystic tumour extending from symphysis to umbilicus and from one iliac crest to the other. It contained a litre of milky fluid. It was attached to the mesentery of the ileum 4 cm. from the root of the mesentery, 10 cm. from the ileocæcal valve. There was no communication with the intestinal canal. Section showed a peritoneal coat, two muscular layers. a muscularis mucosæ, and an epithelial lining; this lining in some places showed cylindrical epithelium, in most places flattened epithelium, and in some situations was devoid of any epithelial element. There can be no doubt that this cyst properly belongs to the group of developmental enterogenous cysts.

ILEOCÆCAL REGION.

Many cysts of intestinal structure have been discovered in this region and have been described as 'ileocæcal cysts'. They may occur in any part of the cæcum, at the ileocæcal junction, or in the adjacent ileum. They may project into the lumen of the gut, being sessile or pedunculated. They may be situated beneath the peritoneum, on the mesenteric or on the anti-
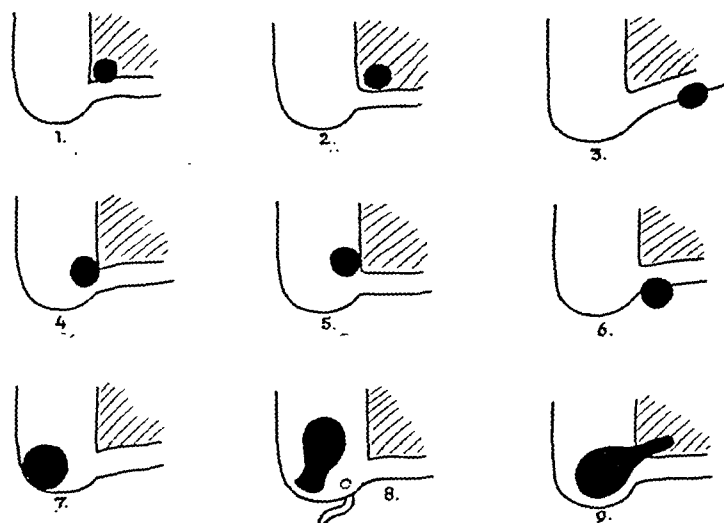
FIG. 45.— Position of developmental enterogenous cysts occurring in the ileocæcal region; the so-called ' ileocæcal cysts '. 1, Bolton and Lawrence ; 2, Sir Arthur Keith, Turner and Tipping; 3, Neupert; 4, MacAuley, Hueter; 5, Sainsbury, Bazin; 6, Quesnel; 7, Blackadder, Girling Ball, Edwards ; 8, Evans ; 9, Ayer.

mesenteric border of the gut. They may be situated within the mesentery, unattached to the gut. These cysts differ in no respect from those we have described as occurring in the duodenum, jejunum, or ileum ; they are developmental enterogenous cysts. The different positions in which they have been found are indicated in *Fig. 45.*

Sainsbury[49] described a cyst which he found post mortem in the first part of the ascending colon. The ileocæcal valve was situated below and somewhat behind the base of the attachment of the tumour (*Fig.* 45 5). The cyst was about the size of a duck's egg. Externally it was covered by a mucous membrane similar to that which lined the large intestine. The inner layer presented the structure of a serous membrane. In places a distinct muscular coat was present. From its position and the muscular fibres in its wall, I consider that this is a case of developmental enterogenous cyst.

Ayer[50] found the lumen of the cæcum occupied by a cyst as large as a duck's egg. It was sessile over about one-fifth of its surface, that portion being attached to the mesocolic border. At the site of attachment there was a funnel-shaped pocket extending for about two inches between the layers of the mesentery of the ileum, and just large enough to admit easily the examining finger. No microscopical examination was made of the cyst wall, but I have no doubt this was a congenital intestinal cyst projecting both into the lumen of the gut and between the layers of the mesentery (*Fig.* 45 9).

Fehleissen[51] reported a multilocular cyst containing 8200 c.c. of clear reddish fluid. There were three layers in the wall : an outer of dense connective tissue ; a middle of very vascular connective tissue, loosely arranged ; and an inner of unstriped muscle fibres arranged longitudinally, but with large bundles having a more or less irregular distribution. Fehleissen says, " the muscle fibres were characteristic ; they differed in no respect from those found in the intestinal tract or in the bladder wall." (*See also* Conant[52], Baldwin[53], and Bolton and Lawrence[54].)

Hueter's[55] case is interesting in that it was situated under the mucosa at the ileocæcal valve (*Fig.* 45 4). It was the size of a cherry-stone. It was lined with cylindrical cells and goblet cells, outside of which was a layer of lymphoid cells (*Fig.* 46).

Sprengel's[56] case occurred in a female, 15 years old, on whom a laparotomy was performed for suspected tuberculous peritonitis. The cæcum was resected for a tumour in that region. A cyst 3 cm. long was found on the ' left side ' of the ileocæcal valve, subserous. It had no communication with the lumen of the gut. Microscopical examination showed columnar epithelium, tubular glands, lymphoid tissue, and a few muscular fibres.

Blackadder[57] reported a cyst of the cæcum in an infant 10 weeks old (*Fig.* 45 7). Microscopical examination showed the surface of the tumour projecting into the lumen of the cæcum covered with mucous membrane similar to that of the intestine ; the cyst was lined with a somewhat stretched layer of columnar epithelium, which, however, in some places was folded into gland formation. Beneath each surface of epithelium was a submucosa infiltrated with leucocytes, and between these again were three more or less distinct layers of muscle.

Neupert[58] reported the case of a boy 10 years of age admitted into hospital with a painful circumscribed swelling in the ileocæcal region. On opening the abdomen a tumour about the size of a hen's egg was found in the ileum 10 cm. from the ileocæcal valve. The tumour occupied the antimesenteric side of the bowel (*Fig.* 45 3). Microscopical sections of the wall showed a lining of cubical epithelium with traces of a submucosa.

Externally and internally the cyst was enclosed by the muscular layer of the intestinal wall.

Turner and Tipping[59] reported the following case : A tense cyst about one inch in diameter was found in the mesentery, in the angle between the ileum and the colon (*Fig.* 45 2). It bulged into both these portions of intestine, causing obstruction at the ileocæcal valve. An attempt was made to remove the cyst, but although it was easily separated from the mesentery
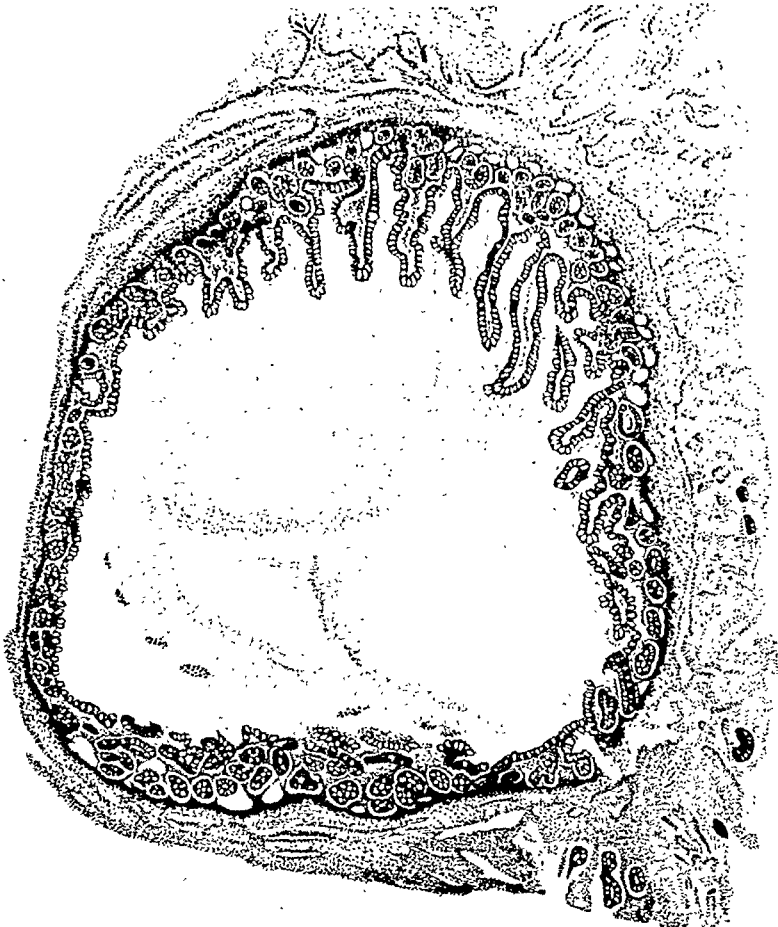
Fig. 46.—Developmental enterogenous cyst situated under the mucosa of the ileum, near the ileocæcal valve. (*From ' Zeigler's Beiträge'*, 1896, xix, 391.)

its walls appeared to be absolutely incorporated with the wall of the ileum and the cæcum. As it seemed that a further attempt at removal would result in damage to the bowel, the cyst was incised and a quantity of white, odourless, glairy fluid was evacuated. There was no communication between the cavity of the cyst and the bowel. The greater part of the cyst wall was cut away and the edges were sewn to the parietal peritoneum. Mucoid material discharged from the wound for some time, but this eventually healed. Since

then on two occasions incisions have been required to allow of the escape of mucoid material which has collected in the cavity. A section of the cyst wall showed a structure closely resembling small intestine.

MacAuley[60] reported a case of a baby girl, age 6 months, operated upon for intussusception. The intussusception having been reduced, a tumour could be palpated in the cæcum at the site of the ileocæcal valve (*Fig.* 45 4). The ileocæcal region was resected, and is now in the Museum of the Royal College of Surgeons (Specimen 548.63).

Girling Ball[61] reported a case very similar to mine (*Fig.* 45 7).

Lotheissen[62] found in a female, age 21, a large cystic swelling in the interior of the cæcum (*Fig.* 47.) He attempted to enucleate the cyst by incising down the tænia, but failing, he resected the ileocæcal region and performed a lateral anastomosis with the transverse colon. This case is almost identical with my own (*Fig.* 45 8).

Bazin[63] reported a case of mucous cyst of the cæcum. After reduction of an ileocæcal intussusception, a hard mass still persisted, situated on the inside of the medial wall of the cæcum just above the ileocæcal valve (*Fig.* 45 5). "Microscopical examination of the cyst wall showed its outer layers consisted of mucosa, submucosa, and two muscle layers, all comparable to that found in the adjoining cæcum ; its inner layers were composed of a fragmentary layer of muscle lined by a single layer of cuboidal cells."

Fig. 47.—Developmental enterogenous cyst in the cæcum. (*After Lotheissen, 'Deutsche Zeitschrift für Chirurgie'*, 1925, 179.)

In the Royal College of Surgeons Museum, Specimen No. 1221.1 is " a spherical retroperitoneal cyst 4 in. in diameter, intimately connected with the lower end of the ascending colon. Histologically the wall of the cyst consists of fibrous tissue with intermingled unstriped muscle fibres, lined with well-developed mucus-secreting epithelium ; here and there the surface raised into low papillæ."

Another specimen in the Royal College of Surgeons Museum (No. E. 16. A) is a cyst removed by Mr. Harold Edwards.[64] The patient was a girl, age 12, who suffered from symptoms resembling those of acute appendicitis. On opening the abdomen a mass was discovered in the right wall of the cæcum just below the level of the ileocæcal valve (*Fig.* 45 7). The mass proved to be a cyst in the cæcal wall. The cyst measured $3\frac{1}{2} \times 1\frac{1}{2} \times 1\frac{3}{8}$ in. The wall contained a narrow band of circular muscle fibres and a submucous layer, and was lined by a single layer of low columnar epithelium.

VITELLO-INTESTINAL TRACT.

At the beginning of the fourth week of intra-uterine life the midgut is in wide communication with the yolk-sac. By the end of the fourth week the midgut has become tubular, and its communication with the yolk-sac has become tubular, forming the vitello-intestinal duct. Coursing over this duct
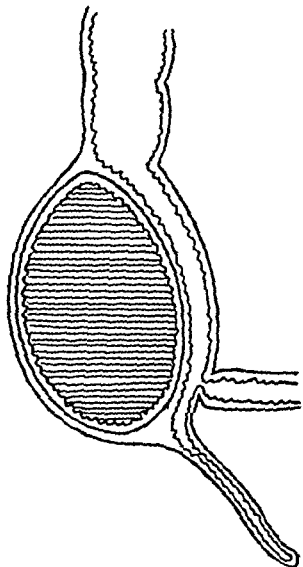
and the yolk-sac is the artery of the yolk-sac—the continuation of the superior mesenteric artery. In the sixth week the vitello-intestinal duct and the vessels accompanying it atrophy. The yolk-sac, by the constriction of the umbilical orifice and formation of the cord, comes to lie on the placenta, where a remnant of it may be found at birth near the implantation of the cord.

Meckel,[65] describing the anomalies of the abdominal portion of the alimentary canal, says : " The special deviations of primitive formation in the intestinal canal are :—

" *a.* The prolapsus of this canal into the umbilical sheath in a case of exomphalos. Instances of this anomaly are most frequent in the small intestine, as, when the development is normal, this portion of the canal enters last into the abdomen.

" *b.* The more or less perfect continuance of its primitive connection with the umbilical vesicle. This anomaly exists in several different degrees. Sometimes the umbilical vesicle continues beyond the usual time, and communicates with the ileon by an open canal which the omphalo-mesenteric vessels attend. Sometimes only a canal exists ; it varies in length, and extends from the same point of the ileon to the umbilicus, where it opens, and the omphalo-mesenteric vessels also accompany it.

" *c.* Finally, sometimes a greater or less prominence exists in this place, a prolongation termed the *diverticulum of the ileon.* This is often accompanied by the omphalo-mesenteric vessels, which float loosely at its extremity, which are attached to the umbilicus or to another region of the intestinal canal, so as to form a plexus." (" Quite recently I found them in a child of three months, arising, as usual, from the superior mesenteric artery and vein, running along the entire length of the diverticulum, and converted at its end into a solid thread, several inches long and hanging free."[66])

" These three anomalies are only different degrees of the same deviation of formation. This is proved by their appearing always in the same place, by their connections with the omphalo-mesenteric vessels, and, finally, by the fact that they always have the character of a primitive formation. That they depend on a primitive formation is proved by the facts that they are always observed in the same place, that they are formed by all the membranes of the intestinal canal, and that they exist simultaneously with other primitive deviations of formation, which arise from the development being arrested, or which, at least, favour their productions. All these circumstances united demonstrate that it is impossible to regard them purely as accidental productions, excrescences, contractions or hernias of the ileon."

Meckel notes the fact that in addition to diverticula whose existence was due to persistence of the vitello-intestinal tract (and which he called ' true ' diverticula) there were others whose existence could not be so explained— these he called ' false ' diverticula. " The false diverticulum differs from the true diverticulum [i.e., Meckel's diverticulum] by its rounded form, by the absence of several superimposed tunics, and, finally, by its occurring in every part, even in the stomach, but most frequently in the duodenum, and by the existence of several at once." Meckel considered that these were dependent upon solutions of continuity in the gut wall, resulting either from mechanical influence as the action of a cutting instrument, a rupture, or from a previous

alteration of texture as from ulcerations. "These solutions of continuity are sometimes complete, and then affect all the tunics; sometimes confined only to the muscular and peritoneal membranes, whence results a hernia of the inner membrane, and the formation of a rounded tumour termed a false diverticulum (div. spurium)."

Meckel, then, recognized two classes of diverticula : (1) Those derived from the vitello-intestinal tract; (2) Those not derived from the vitello-intestinal tract, which he called 'false'. By 'false' he undoubtedly meant any diverticulum not derived from the vitello-intestinal tract; and he considered all these were dependent on 'solutions of continuity'—either traumatic or from alterations in structure, e.g., inflammations—and that in all of them there was an 'absence of several superimposed layers'. We now know that some of these diverticula in stomach, duodenum, and elsewhere are not dependent upon trauma or any inflammatory process, and have no 'solution of continuity' in their coats; they are developmental in origin. But, as Meckel's 'true' diverticula were those, and those only, which were derived from the vitello-intestinal tract, it followed that these developmental enterogenous diverticula were grouped together with those which were obviously 'acquired', and to which alone the term 'false' or 'spurious' might fitly be applied. Because of this imperfect grouping one has repeatedly noted confusion in the description of cases recorded since Meckel's time. Thus, a diverticulum whose walls faithfully repeated the structure of normal gut has been
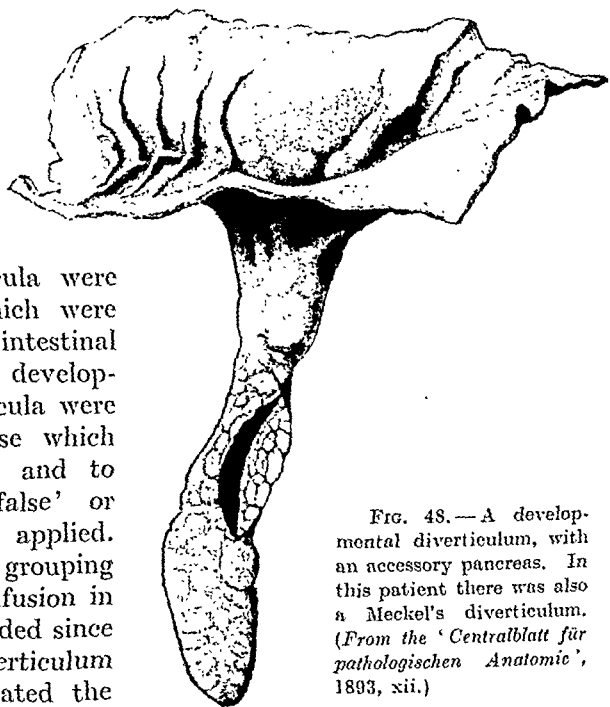
Fig. 48.—A developmental diverticulum, with an accessory pancreas. In this patient there was also a Meckel's diverticulum. (From the 'Centralblatt für pathologischen Anatomie', 1893, xii.)

assumed *ipso facto* to have originated in the vitello-intestinal tract, irrespective of the portion of gut from which that diverticulum arose (including even diverticula of the œsophagus); and a diverticulum not originating in the vitello-intestinal tract has been assumed to be 'false', and therefore 'acquired'. Conclusive proof that the vitello-intestinal tract is not the only possible source of a developmental intestinal diverticulum is afforded by those cases in which more than one such diverticulum has been found.

Nauwerck[67] reported the occurrence, in a man, 43 years old, of a diverticulum 2·3 in. above the ileocæcal valve. This was of the thickness of a lead pencil and 9 cm. long; it arose from the free border of the gut. Attached to its tip there was found an accessory pancreas (*Fig.* 48). This, said Nauwerck, so closely resembled the case described by Zenker that he would have

considered it to be a Meckel's diverticulum with an accessory pancreas—had it not been for the fact that 80 cm. above the ileocæcal valve he found a typical Meckel's diverticulum 3 cm. long. Zenker's[68] case, to which Nauwerck referred, was that of a Meckel's diverticulum 54 cm. above the ileocæcal valve. This was $5\frac{1}{2}$ cm. long. It possessed a small fat mesentery. In this mesentery near the tip of the appendix was an accessory pancreas the size of a cherry.
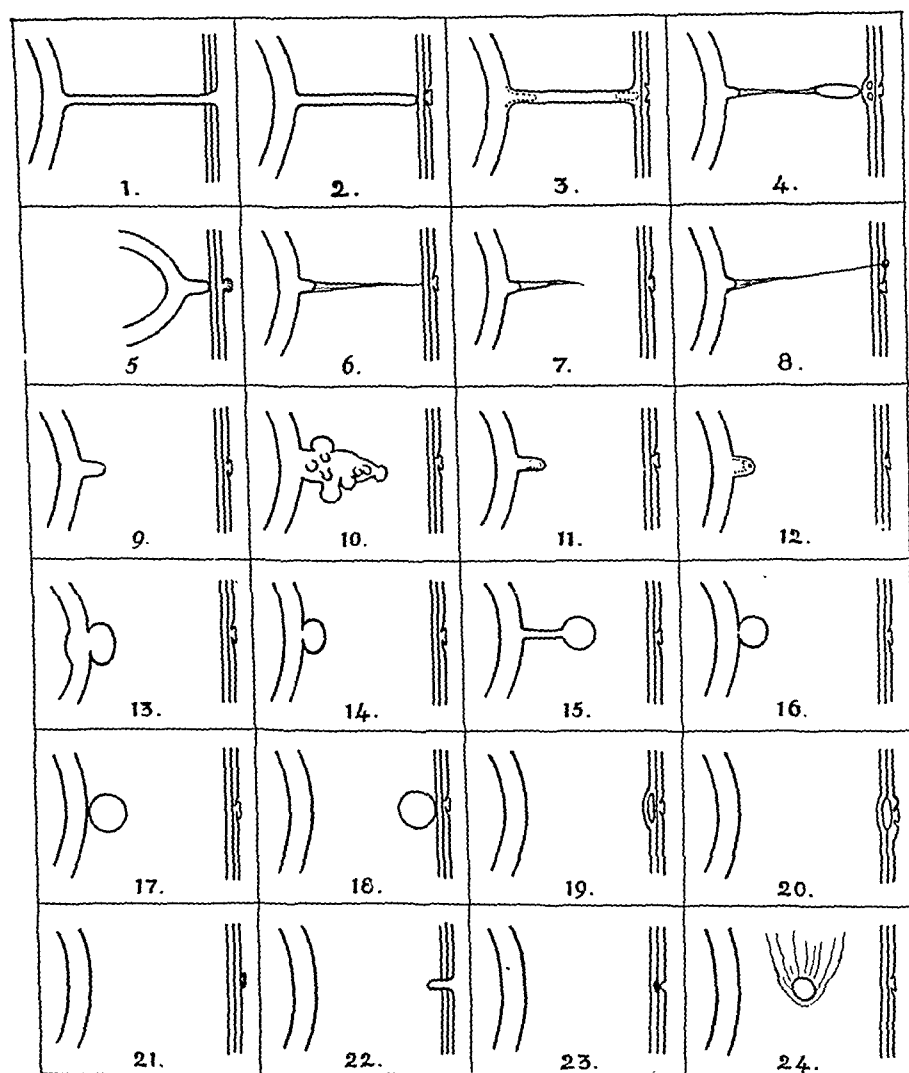
Fig. 49.—Anomalies dependent upon incomplete obliteration of the vitello-intestinal tract. The numbers correspond to those of the 24 cases cited in the text.

Roth[17] reported a case in which there was a cyst lined by gut epithelium in the thorax and another connected with the third portion of the duodenum; also a diverticulum of the ileum lying between the layers of the mesentery, and at its extremity a gut-lined cyst (see Fig. 36). In this case there must have been three diverticula from the primitive intestinal tract.

The proper classification of intestinal diverticula is : (1) Developmental : (a) Those consequent on failure in the obliteration of the vitello-intestinal tract (Meckel's diverticula) ; (b) Those consequent on the persistence of the diverticula which normally occur in the fœtal entoderm. (2) Acquired.

Although the anomaly most commonly associated with imperfect obliteration of the vitello-intestinal tract is the persistence of its intestinal attachment (i.e., Meckel's diverticulum), it should be noted that any portion of this tract may persist, either within the abdominal cavity, or in its passage through the abdominal wall. It should also be noted that any portion of this tract may show heterotopic differentiation. Fig. 49 indicates these various developmental anomalies, and illustrative cases follow, the numbers corresponding to the numbers of the diagrams in the figure.

1. F. W. King[69] reports a case in a boy, age 14 months. Ever since the funis came off, on the 11th day after birth, he is stated to have had a discharge from the umbilicus of a thin yellow colour, and of a faint odour. There was no doubt that the sinus communicated with the small intestines. This was later proved at a post-mortem examination. The diverticulum, about 3 in. long, was found adhering to the umbilicus, and an adventitious cord appears to have compressed the ileum just below its connection with the diverticulum.

2. Hilton Fagge[70] quotes a post-mortem by Dr. Wilks on a girl of 10 who died of peritonitis. A Meckel's diverticulum was found about 15 in. above the cæcum. This was attached to the abdominal wall in the region of the umbilicus. It was pervious as far as the umbilicus, where it terminated in a blind end. It would admit an ordinary lead pencil.

3. Barron[71] at an autopsy found a narrow Meckel's diverticulum possessing a thick cord-like attachment to the abdominal wall in the region of the umbilicus. The umbilicus itself appeared normal. The proximal cavity was lined by mucosa exactly resembling that of the small intestine. In the apparently solid portion of the cord-like prolongation was a small cavity, 2·5 cm. by 2 mm., separated from the proximal diverticulum by a thin connective-tissue septum. This narrow cyst was lined by gastric mucosa.

4. Wilkie[72] operated on a boy, age 15, for acute intestinal obstruction. He found, about a foot from the ileocæcal valve, a tense sausage-shaped cystic swelling ; this was attached by a broad and twisted pedicle to the ileum, and its other end was moored to the abdominal wall at the level of the umbilicus. At the point of attachment to the ileum it had, by its torsion, caused an acute kink, with complete obstruction of the intestinal lumen. On excising the cyst, two other sessile cysts could be felt in the abdominal wall in the region of the umbilicus. " They evidently represented remnants of the omphalo-mesenteric duct in the abdominal wall, which had developed into separate cysts."

5. Cullen[73] reported a case of an umbilical polyp associated with a Meckel's diverticulum (Fig. 50). As Cullen says, " this case came within an ace of being one of patent omphalo-mesenteric duct."

6. Falk[74] found in a man, 20 years of age, a diverticulum 4½ in. long, two feet above the ileocæcal valve ; a solid pseudomembranous ligament 1½ in. long ran from its apex to the abdominal wall an inch from the umbilicus. A

band which united the diverticulum and the mesentery had given rise to intestinal obstruction.

7. Meckel's[66] case, to which reference has already been made. The vitelline vessels form a cord hanging free.

8. Taylor[75] reports a case of Meckel's diverticulum 4 in. long, from the apex of which a fibrous band passed to the abdominal wall behind the umbilicus. In the superficial tissues of the umbilicus was a small hard reddish nodule the size of a pea, visible and palpable on the suface. Microscopically, the apex of the diverticulum was seen to be lined by mucous membrane identical with that of the gastric fundus. The umbilical nodule, covered by normal squamous

Fig. 50. — An elliptical incision including the umbilical polyp has been made and the umbilicus lifted well away from the abdominal wall. Passing off from the loop of small bowel is a Meckel's diverticulum. This is firmly fixed to the inner surface of the umbilicus. Firmly attached to the outer surface of the umbilicus is the umbilical polyp. A small hole on the surface of the polyp, into which a probe can be passed for 8 mm., is the remnant of the lumen which formerly was continuous with Meckel's diverticulum. The omphalo-mesenteric artery and vein still persist. The polypus is covered by mucosa typical of the small intestine. (*From 'Surgery, Gynecology and Obstetrics'*, 1922, xxxv.)

epithelium, was composed of fibrous tissue in which no heterotopic tissue was seen. It was continuous with the fibrous band running to the apex of the diverticulum.

9. This represents the classical Meckel's diverticulum.

10. A Meckel's diverticulum may possess one or more nodular projections ; this one, removed by Mr. Rock Carling, has nine such accessory diverticula. (Westminster Hospital Museum, No. 525C.)

11. Taylor[75] reported 5 cases of Meckel's diverticulum at the apex of each of which the mucosa faithfully reproduced the structure of gastric mucosa.

12. In three of the cases of Taylor just mentioned, the superficial heterotopia were associated with deep heterotopia in the shape of aberrant pancreatic tissue.

13. A loop of ileum with an enormous Meckel's diverticulum (*Fig.* 51). The sac held 845 c.c. ; it is sessile on the gut, with which it communicates by a very wide opening. (R.C.S. Museum, No. 548.W.)

14. A large ovoidal Meckel's diverticulum, 4 in. in its chief diameter. Removed by Sir Charters Symonds. (R.C.S. Museum, No. 548X.)

15. Meckel's diverticulum in the form of a large pedunculated cystic swelling. (*See* Roth's case, p. 55 and *Fig.* 39.)

16. Struthers[76] reported a case of death from peritonitis due to leakage from a rounded swelling which was attached by a broad base to the upper
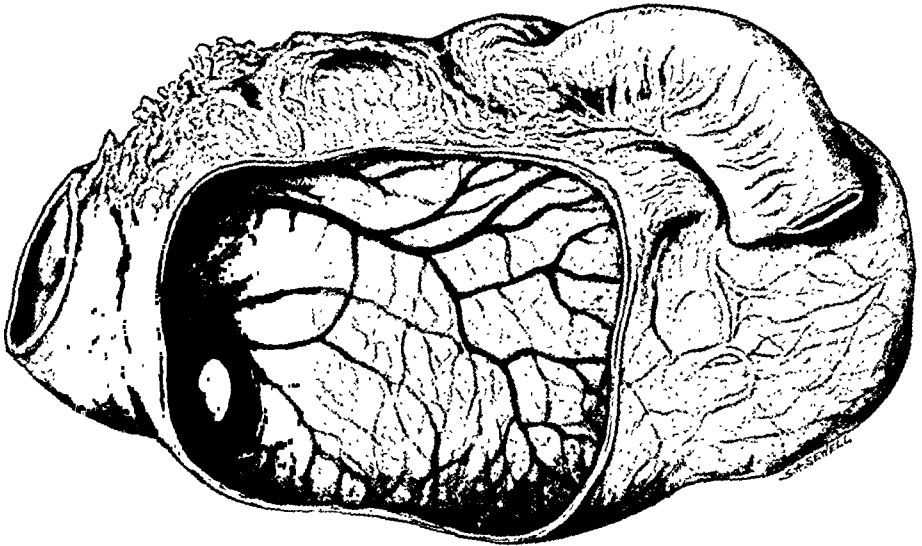
FIG. 51.—Persistence of wide communication between the mid-gut and the vitello-intestinal tract. (*R.C.S. Museum*, No. 548.W.)

aspect of the mesentery two feet above the ileocæcal valve, and lying up against the small intestine. Section showed this to be a thick-walled cyst which communicated with the lumen of the adjacent gut by a minute canal (*Fig.* 52). The interior of the cyst and of the canal were lined by columnar epithelium ; and the walls were composed of two layers of muscle fibres, longitudinal and circular.

17. Meckel's diverticulum forming a cyst, sessile on the gut, but having no communication with it. (*See* Räsfeld's case, p. 73 and *Fig.* 56.)

18. Schaad[77] found in the abdomen of a woman, age 33, a cystic tumour attached to the abdominal wall two finger-breadths below the umbilicus. It communicated with a smaller cyst. In the cyst was a chocolate-coloured fluid containing cholesterol. The cyst was lined with normal intestinal mucosa.

FIG. 52.—Meckel's diverticulum forming a thick-walled cyst, communicating with the gut by a minute canal. (*From the 'Edinburgh Medical Journal'*, vii, No. 4.)

19. Wyss[78] reported a cyst of the abdominal wall, ¾ in. above the umbilicus. It was the size of a bean, and lay between the muscle and the

peritoneum. The cyst contained a turbid mucoid fluid. In this fluid was a great number of cylindrical ciliated epithelial cells. The wall consisted of connective tissue with numerous fine elastic fibres. The inner lining was a continuous layer of ciliated epithelium.

20. Colmers[79] reports a case occurring in a woman, age 46, in whom he found a cyst the size of a small hen's egg attached to the parietal peritoneum, near the umbilicus. This cyst lay between the parietal peritoneum and the sheath of the rectus muscle, to which it was firmly adherent by a broad base. Below this, but not attached to it, was a smaller tumour the size of a hazel-nut ; this, too, was adherent to the abdominal wall. It terminated in a short firm cord-like band which opened into the umbilicus. This band on section showed the structure of the remains of the omphalo-mesenteric vessels (*Fig. 53*), in which will be observed two patent vessels, containing blood and each surrounded by unstriped muscle fibres. The walls of the cysts are composed mainly of connective tissue, in which there is marked calcareous degeneration. No epithelial lining could be demonstrated inside the larger or the smaller cyst, but the inner lining of the larger cyst consisted of a narrow layer of necrotic tissue. At the base of the larger cyst and communicating with it by fine openings were two prolongations. These are lined by very tall cylindrical epithelium very like Lieberkühn's glands ; here and there villi project into the lumen (*Fig. 54*). This layer rests on a muscularis mucosæ ; then follow unstriped muscle fibres, which, although not arranged into two layers as regularly as that found in the gut wall, yet can readily be differentiated into circular and longitudinal fibres.

21. Stone[80] collected 38 cases of umbilical polypus, 34 of which were composed of normal intestinal epithelium ; 4 were composed of gastric mucosa. In 3 of the cases reported by A. L. Taylor, two were covered entirely with mucosa of intestinal type, one with gastric mucosa. Taylor refers to a case reported by Tillmanns in a boy of 13 : a pedunculated tumour, the size of a walnut, increased in size after each meal, and in the course of a few minutes secreted 2 to 3 c.c. of clear fluid identical with gastric juice.

Many instances have been recorded in which vestiges of the vitello-intestinal tract at the umbilicus have shown heterotopic differentiation. Nicholson says : " Pyloric glands have been recorded in an umbilical polypus by Tillmans. Cardiac glands were found in the umbilical part of a patent vitelline duct by Salzer, and at the apex of a Meckel's diverticulum by Meulengracht. Brunner's glands are described by Kern in the extroverted distal end of a patent duct, and by Tschiknawerow at the apex of a Meckel's diverticulum. Wright found a small encapsulated pancreas in the subcutaneous tissue of the umbilicus of a girl of 12." The diversity of epithelial structure found in this situation is accounted for by the fact that in the early stage of development the vitelline duct was almost as wide as the whole of the primitive gut ; so that there is no reason to suppose that the epithelium of the vitelline duct does not share all the prospective potentialities of the primitive gut.

22. Roser[81] reports a case in a man who had been operated upon for a tumour in the region of the umbilicus. A fistula persisted, and from this there was a slimy watery discharge. On examination it was found to pass into a cavity about 6 cm. in diameter. As much as possible of the lining
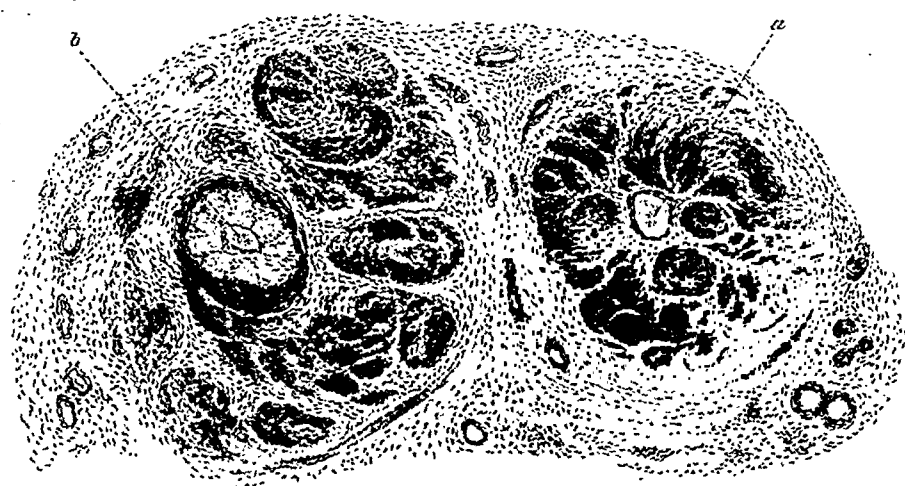
FIG. 53.—Section of fibrous band connecting cyst to umbilicus. *a* and *b* are the remains of the omphalo-mesenteric vessels, each containing blood and surrounded by unstriped muscle fibres. (*From Colmers, 'Archiv für klinische Chirurgie', 1906, lxxix.*)
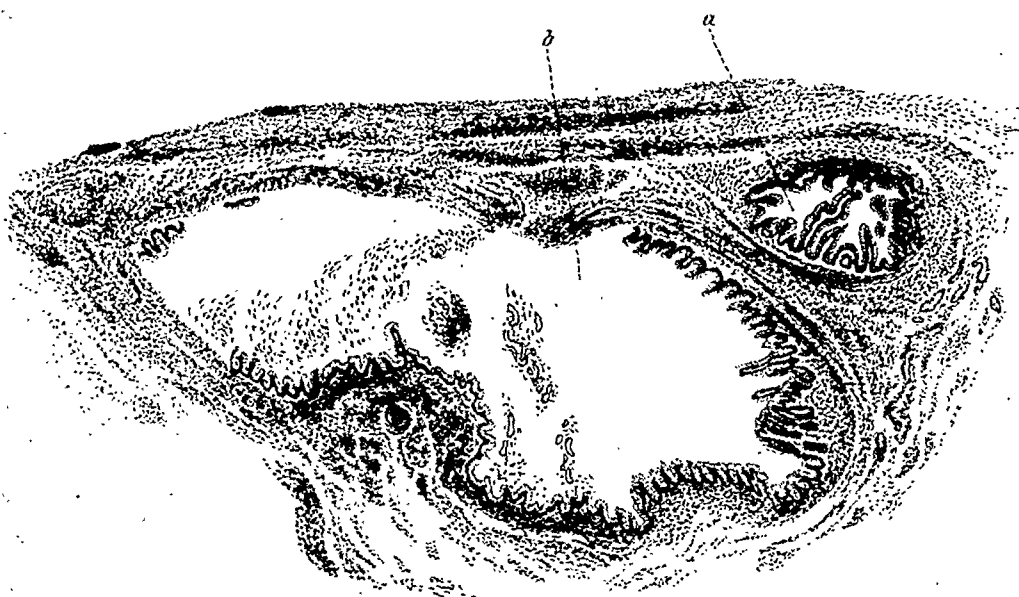
FIG. 54.—Same case as *Fig.* 53. Two prolongations (*a* and *b*) from a cyst near the umbilicus. Each is lined by tall cylindrical epithelium ; villi project into the lumen. This layer rests on a muscularis mucosæ ; and this on circular and longitudinal unstriped muscle fibres. (*From Colmers, 'Archiv für klinische Chirurgie', 1906, lxxix.*)

was dissected out. The mucous lining was found to contain Lieberkühn's glands.

23. John H. Wright[82] reports in a female child, 12 years old, the occurrence of an umbilical fistula which had been present since birth. A. T. Cabot dissected this out, down to the level of the peritoneum. The peritoneal cavity was opened and explored ; no connection of the fistula with the intestine could be made out. Microscopical examination showed " that the specimen for the most part consisted of dense connective tissue together with some fat tissue. The fistulous tract appeared to correspond to an invagination of the epidermis. In the midst of the substance of the specimen, at a point about 2 mm. from the apex of the invagination of the epidermis, an irregularly-shaped nodule, $3\frac{1}{2}$ mm. in greatest diameter, was found. Microscopical examination of this nodule showed the structure of pancreas. Amongst the tubules were undoubted islands of Langerhans.

24. In a case recently operated upon at Westminster Hospital by Mr. Stanford Cade, for the radical cure of an inguinal hernia, the vermiform appendix was found occupying the sac. The appendix was removed. Exploration of the neighbouring peritoneal cavity revealed a small tumour in the great omentum (*Fig.* 55). This was excised. It proved to be a cyst lined by a layer of columnar ciliated epithelium ; outside this were a muscularis mucosæ, a layer of connective tissue, and several layers of muscular fibres—some cut longitudinally, and others transversely. This is certainly a develop-

FIG. 55.—A developmental enterogenous cyst, situated in the great omentum. This may have been derived from the vitello-intestinal tract. (× 2.)

mental enterogenous cyst. It may have been derived from the vitello-intestinal tract, have become completely detached from the parent gut, and grafted on to the omentum. (Cf. Struther's case, p. 70 and *Fig.* 52, and Roth's case, p. 55 and *Fig.* 39.)

Räsfeld,[83] in his work on Meckel's diverticulum, noted this change from diverticulum to cyst so clearly that I quote a few of his sentences and copy his diagram (*Fig.* 56). " Rarissime fit ut latus intestini, in quo diverticulum inhæret, claudatur, diverticulum autem ipsum, partim modo evanescat, ita ut in cystæ formam in ileo insedeat."

Fitz[84] describes a specimen in the Warren Museum (No. 4903) found at the autopsy of a patient who died of chronic

FIG. 56.—Medium sectum diverticuli, in formam cystæ, 10″ a valvula colli, in puellæ neonatæ, omnino bene formatæ, ileo, infixi, quod peritonaeo arcte circumclusum. iisdem membranis constabat, quibus intestina ; muco perspicuo erat impletum. (*After Räsfeld,* ' *De Hernia Littrica Berol* ', 1852, 11.)

pleurisy. About one metre above the ileocæcal valve was a cyst of Meckel's diverticulum. 3 cm. in length and about 1 cm. in diameter. No communication could be found between it and the lumen of the intestine.

VERMIFORM APPENDIX.

Hedinger[85] described an autopsy on a child who died at birth, death being consequent on protracted labour due to hydramnios and transverse presentation. A small umbilical hernia contained a piece of large intestine and the vermiform appendix, the distal end of which was adherent to the hernial sac. The proximal portion of the appendix was normal; the distal
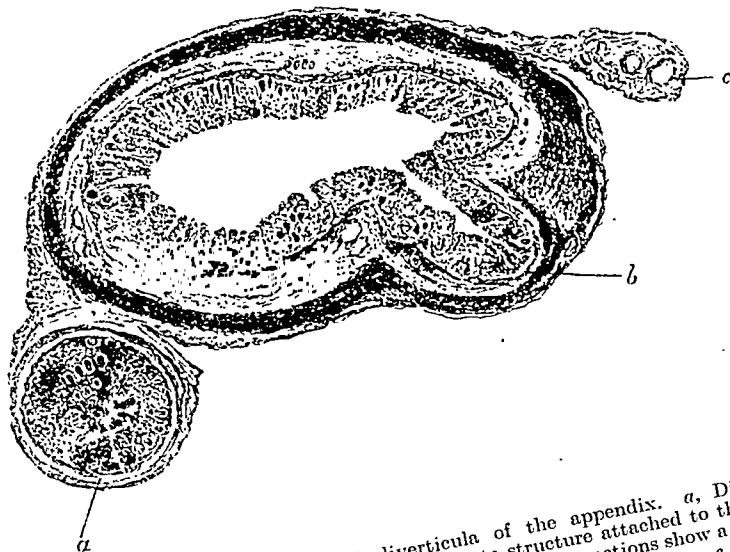
FIG. 57.—Multiple developmental diverticula of the appendix. *a*, Diverticulum of the appendix, appearing in this section as a separate structure attached to the appendix by serosa ; a further section shows a common submucosa ; other sections show a lumen common to *a* and to the appendix. *b*, Diverticulum extending to the muscular coat. *c*, Meso-appendix. (From ' *Virchow's Archiv* ', clxxviii, *Fig.* 1, page 172.)

third was greatly diminished in size and of peculiar uneven surface, studded with small knobs of various sizes, all subserous. Microscopical examination revealed many congenital diverticula (*Fig.* 57). In addition to these there were in the submucosa many areas of mucosal structure showing greatly branched Lieberkühn's glands with tall cylindrical epithelium.

SIGMOID.

Garnett Wright[86] described a diverticulum 37 in. long which commenced at the upper end of the sigmoid loop of the colon (*Fig.* 58). It ran at an acute angle downwards and entered between the layers of the mesosigmoid. Here it occupied the cavity of the sigmoid colon, and became of a very large size, being much greater in diameter than the bowel. On reaching the end of the sigmoid loop the diverticulum separated from the colon, to which up to now it was intimately adherent, and narrowing abruptly, passed from between the layers of the meso-sigmoid to lie behind the posterior parietal peritoneum.

FIG. 58.
Garnett Wright's case.

Here it turned upwards and expanded into a blind sac, reaching a position on the posterior abdominal wall behind the stomach. In the recent state the circumference of this portion of the diverticulum was 17 in. The diverticulum possessed two muscular layers, an outer longitudinal and an inner circular. The inner coat of the diverticulum consisted of a mucous membrane thrown into irregular folds lined by epithelium of the usual large-intestine type.

'REDUPLICATIONS.'

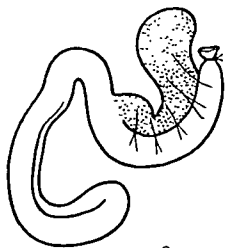I think there can be little doubt that many cases recorded as reduplications of portions of the intestinal tract were either developmental diverticula or enterogenous cysts.

Fairland,[87] operating to relieve intestinal obstruction in a child born with an imperforate anus, opened the abdomen, withdrew a distended portion of gut, and opened this; a large quantity of fæces rushed out. At the post-mortem examination it was found that the opening had been made into a large diverticulum (*Fig.* 59 c), 13 in. long, which arose from the duodenum about 1½ in. from the pylorus. In this case the gut was said to have 'bifurcated', but there can be little doubt that the second portion of gut was a developmental diverticulum.
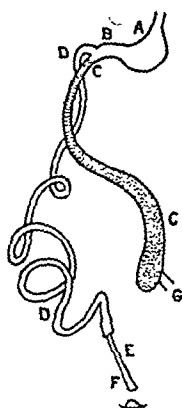
FIG. 59.—Fairland's case.   FIG. 60 —Lockwood's case.   FIG. 61.—Meckel's case.
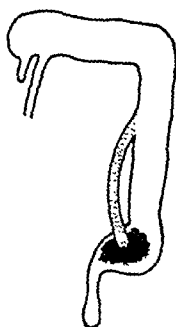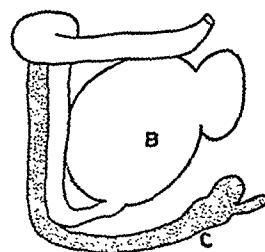
C. B. Lockwood[88] described the case of a man, age 57, who died of intestinal obstruction (*Fig.* 60). "At the post-mortem examination, the cæcum was found in the right hypochondriac region, beneath the liver. The colon crossed from the cæcum to the splenic curve, and thence descended into the pelvis. Here a remarkable abnormality occurred. The descending colon was double; the two tubes were upon the same plane, the smaller one nearer the vertebral column. Each possessed appendices epiploicæ. The tube which was nearest the spine had a very small canal in its centre, which appeared to have a mucous lining. This canal opened above into the colon by means of a small aperture; below, it was lost in a mass of malignant disease. It contained no fæces. Its walls were moderately thick. The malignant mass which received the end of the diverticulum also concealed the end of the outer tube, which was the colon proper. It is very hard to imagine how a tube which is at first single can afterwards become double. Meckel[89] has pictured the intestines of a fœtus in which there were two cæca (*Fig.* 61). The ileum

opened into B, and from it the gut extended upwards towards the hepatic curve. Below this cæcum was another, C, from which a tube extended parallel to and outside the first, and also continuous with the transverse colon, at the hepatic curve. Meckel[90] also figures a case in which the cæcum was bifid." Commenting on Lockwood's case, Dr. Symington, of Edinburgh, remarked that one of the two tubes in the position of the descending colon might be a diverticulum, there being no proof that they united below.

Fitz[91] recorded a case of "intra-mesenteric duplication of the intestine"

FIG. 62.—Fitz's case.

(*Fig.* 62). "Two more or less parallel intestinal tubes, cut transversely across in their continuity, are contained within a single mesentery. The blood-vessels of the latter terminate in the wall of the outermost tube, first supplying branches to the inner tube. The diameter of the outer tube is relatively uniform throughout, while that of the inner, in general somewhat narrower, becomes dilated in the immediate vicinity of an opening through which the canals of the tubes communicate with each other. The contiguous portions of the walls of the two tubes are in close proximity to each other throughout the greater part of their course, and are fused near the common opening. The walls are composed of mucous, muscular, and peritoneal coats. The mucous membrane of the outer tube shows slightly projecting transverse folds in the vicinity of the opening, while that of the inner tube is relatively smooth. Villi and crypts are present in both. The opening between the tubes is rounded, sharply defined, one-third of an inch in diameter, and appears to be covered by mucous membrane. The canal of the inner tube is contracted in the immediate vicinity of the opening, and its wall at this part is thickened and fibrous." I think this is a case of developmental enterogenous diverticulum which, on reaching the outer surface of the parent gut, extended orally and aborally. Unfortunately no record was made of the length of the diverticulum.
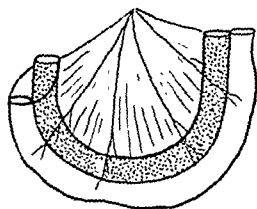
A glance at Roth's case (*Fig.* 63 ; *see also Fig.* 40), I think, enables one to understand more clearly the development of the case described by Fitz.

In Roth's case we have an undoubted developmental diverticulum. This on reaching the serous

FIG. 63.—Roth's case.

surface of the parent gut extended aborally along it for a distance of 10 cm. Had it bifurcated at its commencement and extended orally as well as aborally the resulting condition would have been similar to that figured by Fitz.
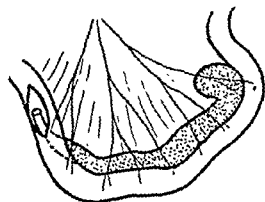
In the Royal College of Surgeons Museum, Specimen No. 1222.1 is "a piece of small intestine of an ox to one side of which there is intimately attached a long tubular cyst, 17 in. in length, and of the same calibre as the intestine itself ; the groove between the two, on the free aspect, is filled with fat. At either end the cyst terminates blindly, and for a short distance is unconnected with the gut (*Figs.* 64 and 65). In the recent state the cavity was filled mainly with epithelium. Microscopical examination shows that the

cyst is furnished with a double muscular wall, and a mucosa with muscularis mucosæ, but without lymphatic tissue. The mucosa bears no villi or papillæ, and is invested with a stratified epithelium devoid of a stratum granulosum. The cyst has probably arisen in the omphalo-mesenteric duct, the original columnar epithelium of which has become transformed into the kind mentioned." I think, as in Fitz's case, this cyst originated in a develop-
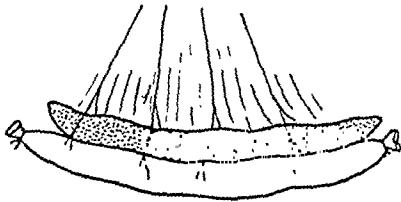
FIG. 64.—Specimen in R.C.S. Museum (No. 1222.1).

mental diverticulum, which, on gaining the surface of the parent gut, bifurcated and extended orally and aborally. That the two ends of the cyst are not connected with the gut confirms this suggested mode of origin.

Garnett Wright's case (*Fig.* 58) so closely resembles Roth's case that I think it should be assigned to the group of developmental enterogenous diverticula.

Pritchard's case, to which reference has already been made, is that of a second stomach situated behind the peritoneum. This, I consider, started as a developmental diverticulum from the fore-gut, which, becoming detached, formed an enterogenous cyst. The same origin must be ascribed to Ahrens' case in which, behind the peritoneum, was found a cyst which resembled an hour-glass stomach and 26 cm. of small intestine. Microscopical examination of the cyst wall revealed a structure identical with that of a stomach and of small intestine, save that the mucosa in different sections consisted of " stratified and cuboidal cells, stratified ciliated cells, tall columnar, and flat cells." These two cases well illustrate the potentialities of a small isolated portion of the fœtal entoderm. So, too, does the following description of the distal end of a vitello-intestinal tract.

FIG. 65.—A piece of small intestine of an ox, to one side of which there is intimately attached a long tubular cyst. $(\times \frac{1}{4}.)$ (*R.C.S. Museum*, No. 1222.1.)

Nicholson[6] reports a specimen removed from a boy of 8. It consists of a narrow tube, about 2 cm. in length, the distal half of which is gradually dilated to form a funnel-shaped organ, which opened on to the base of the umbilicus without, as is frequently the case, having undergone eversion. The proximal end was attached to a coil of small intestine, identified as ileum.

" The mucous membrane of the proximal end of the duct is identical with that of the lower part of the small intestine.

" The widened distal end of the duct is lined by a highly differentiated and beautifully finished fundal mucous membrane. Where the duct becomes narrowed to pass into its intestinal portion the fundus is separated from the iliac mucous membrane by a narrow pylorus. This consists of masses of large coiled glands, whose efferent superficial segments pursue an irregular course between the fundal glands, to open upon the surface among them. The line of union between the gastric and intestinal epithelium upon the surface of the duct is sharp and abrupt. Pyloric glands extend for a short distance into the beginning of the intestinal mucous membrane. Here they occupy its deep surface beneath the crypts of Lieberkühn. They thus appear to correspond with Brunner's glands, although they do not penetrate the muscularis mucosæ. The last-named structure consists of a regular sheet of plain muscle fibres, which is thickened beneath the ring of pyloric glands to form a sphincter. A glance at *Fig.* 66 demonstrates the highly organized structure and morphological finish of this small ectopic stomach, with its broad fundus and its narrow pylorus. Not only is its structure perfect, but there is evidence that its physiological secretion was identical with that of the stomach."

FIG. 66.—Meckel's diverticulum 2 cm. long. The distal end, lined by fundal and pyloric mucosa. (*From the 'Journal of Pathology and Bacteriology'.* 1923, xxvi.)

Nicholson records another narrow Meckel's diverticulum, about 15 cm. in length. " The greater part of this is lined by a perfectly differentiated fundal mucous membrane, whose semi-digested condition proves the presence of a secretion analogous to the gastric juice."

EPITHELIAL MISPLACEMENTS.

Indirect evidence of the common occurrence and widespread distribution of fœtal diverticula is afforded by a study of the epithelial misplacements of the alimentary tract. The reader is referred to most illuminating writings on this subject by G. W. Nicholson[92] (" Heteromorphoses of the Alimentary Tract ") and by A. L. Taylor[57] (" Epithelial Heterotopias of the Alimentary Tract.")

Taylor, working with the material obtained in two years from the operation theatres and the post-mortem room of the Leeds General Infirmary, found 69

cases of epithelial misplacement in the intestinal epithelium. In a series of 81 cases reported by him, the type of epithelium misplaced and the situation in which it was found are shown in the following table :—

Type of Misplaced Tissue	Region Affected	No. of Cases
1. Superficial heterotopia		
a. Gastric	Œsophagus	6
	Duodenum	2
	Small intestine	1
	Meckel's diverticulum	5*
	Umbilicus	1
b. Intestinal	Stomach	36
	Umbilicus..	3†
c. Duodenal	Stomach	1
2. Deep heterotopia		
a. Submucous glands	Stomach	1
b. Intramural cysts	Stomach	1
c. Adenomyoma	Stomach	6
	Duodenum	3
d. Accessory pancreas	Stomach	6
	Duodenum	7
	Jejunum	3
	Meckel's diverticulum	3
	Total	81

* Includes the three cases in which heterotopic pancreas was also present.
† Includes the case showing gastric type heterotopia.

Seeing that 69 of these cases were obtained in two years from the operation theatre and the post-mortem room of the Leeds General Infirmary, it is safe to assume that if minute routine examination of the whole alimentary tract were the invariable rule, heteromorphoses of the intestinal tract would prove to be of fairly frequent occurrence.

Nicholson, in his studies of the heteromorphoses in the human body, says that " they can be all referred to anomalies of differentiation ; cell differentiation is, within wide limits at all events, the result of stimulation from without, of environment in fact. When this is normal, differentiation will inevitably be so too ; when cells are exposed to abnormal influences they will as inevitably undergo differentiation in an abnormal direction." " The entodermal cells lining any 'bud' from the primitive intestinal tract possess all the potencies of the gut of which they have barely ceased to form a part. But in the very process of budding their environment alters. They are thus forced to develop certain of their original potencies and to suppress others. By so doing the immediate environment—the stimuli, internal as well as external, to which these are subjected—is again altered. If the sequence of stimuli or changes of environment is orderly the cells will, in the fullness of time, acquire the structural characters of pancreatic tissue or of liver tissue. If it be interrupted and altered to an extent to which the cells can only respond by the development of some other of their original potencies, an abnormal or heterotopic tissue must result."

A specimen described by Lewis and Thyng illustrates this. They observed in a 41·6-mm. rabbit embryo a single diverticulum. It possessed an oval lumen which emptied into the intestine. It was lined with smooth epithelium, contrasting with the much enfolded intestinal layer which was in process of forming villi. These writers state : " It is well known that a small pancreas may develop at various places along the lumen of the small intestine. We have examined four such cases—one from the duodenum, two from the jejunum, and one from the umbilicus. The position of these structures accords with that of the early diverticula."

A. T. Lewis[93] says it is possible that accessory pancreases sometimes develop in relation with embryonic intestinal diverticula. In the embryo to which reference has already been made (see Fig. 23) it was noted that a small cyst, obviously derived as a diverticulum from the duodenum, was situated in the mesenchyme. In this same specimen was a diverticulum of the duodenum situated above the dorsal pancreas. Below the duct of the dorsal pancreas was another elongated, unbranched diverticulum 0·55 mm. long and about 0·07 mm. in diameter. This outgrowth had a distinct lumen, and was somewhat expanded at its distal extremity, where the cells were of the same nature as those of the other portions of the pancreas. In the small detached cyst, however, the epithelium of the cyst which corresponds with the accessory pancreas was quite unlike that of the pancreas. The pancreatic tubules, about 0·05 mm. in diameter, contained only a minute lumen, whereas the cyst had a cavity 0·22 mm. in diameter, equal to that of the intestine. Beyond the diverticulum with pancreas at its distal extremity there were eighteen diverticula along the anterior limb of the intestinal loop. In this single specimen we have nineteen simple diverticula of the intestinal wall, one elongated diverticulum containing pancreatic structure at its tip, and a cyst—derived from a diverticulum—the lining cells of which differed from the entoderm of the neighbouring intestine and from the pancreatic cells.

I think there can be no doubt that the cells lining developmental enterogenous diverticula and cysts are exposed to influences which differ from those to which the adjacent normally situated cells are exposed ; hence they are likely to differentiate into cells which differ from those in their immediate vicinity.

The association of heterotopic tissue with diverticula has been frequently observed, and one is driven to the conclusion that such conditions as that which follows must have originated in the diverticula of the fœtal entoderm. A. L. Taylor[75] reported the case of a woman, age 52, who died of carcinoma of the rectum. On the posterior wall of the œsophagus at the level of the cricoid cartilage was a small whitish area about ⅜ in. long, one margin of which showed a definite break in the epithelium. Microscopically this is found to be the mouth of a small flattened diverticulum or pocket in the mucous membrane, with edges closely apposed to each other. This pocket is surrounded everywhere by a thick muscularis mucosæ, and does not protrude for any distance into the submucous tissues. Its walls are lined by gastric glands entirely of cardiac type, some of them much dilated and containing cell débris or secretory products. The transition from œsophagus to gastric epithelium takes place abruptly at the mouth of the diverticulum.

Taylor also described a small diverticulum on the posterior wall of the duodenum. The diverticulum, of irregular shape, was about ¼ in. across and directed obliquely towards the pylorus. The floor of the diverticulum was lined by gastric (fundal) mucous membrane, and beneath this the submucous glands were absent. Distal to this, and about ½ in. from the pylorus, was a small whitish patch. This, being microscoped, proved to be a patch of fundal glands lying in the duodenal mucosa. It was confined to the inner side of the muscularis mucosæ, beneath which the submucous layer was devoid of Brunner's glands.

We may hence conclude that apart from the enterogenous cysts which are derived from the vitello-intestinal tract, the cysts of similar structure which are found in the abdomen or in the thorax originated in the diverticula which are found in the fœtal entoderm, as described by Keibel and by Lewis and Thyng. Most of these diverticula disappear ; some persist. Of those that persist, some become lined by epithelium which differs from the immediately adjacent epithelium and resembles that of some other portion of the intestinal tract : these are the superficial and deep heteromorphoses. Some develop into gross diverticula, and others into closed cysts : these are the developmental enterogenous diverticula and cysts. Such diverticula and cysts are usually lined by epithelium similar to that lining the adjacent gut, but occasionally they are the seat of superficial or deep, or of both superficial and deep, epithelial heteromorphoses.

SUMMARY.

The cyst here recorded, one of the group commonly designated 'ileocæcal cysts', is a developmental enterogenous cyst. All cysts found in the abdomen, or in the thorax, or at the umbilicus, having the structure of gut, must have been derived from the primitive intestinal tract ; they are developmental enterogenous cysts.

These cysts originated either in the vitello-intestinal tract, or in the diverticula which are found in the developing entoderm of the embryo, as described by Keibel, and by Lewis and Thyng.

Some of these developmental diverticula persist as diverticula, and increase in size.

Instances are given of enterogenous cysts which originated in developmental diverticula situated in those segments of the primitive intestinal tract which later became œsophagus, stomach, duodenum, jejunum, ileum, ileocæcal region, vermiform appendix, or sigmoid ; also of enterogenous cysts which originated in some unobliterated portion of the vitello-intestinal tract.

The great variety shown in the structure of the inner lining of these cysts is in some cases accounted for by intracystic pressure, in others by inflammatory changes, and in many by an error in differentiation of the lining cells resulting in heteromorphosis of the epithelium.

It is probable that all the epithelial misplacements of the intestinal tract, whether occurring in enterogenous cysts, in developmental diverticula, or as the superficial and deep heteromorphoses of the intestinal tract, originated in the diverticula which are found in the developing entoderm of the embryo.

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HÆMANGEIOMATOUS CYSTS OF THE CEREBELLUM.

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THAT cerebellar cysts frequently have a small knot of tumour in their walls has been known for half a century. In 1872 Hughlings Jackson[1] found in the wall of a cerebellar cyst a tumour, the size of a shilling on its cut surface, which extended to the surface of the cerebellum. He noted that the inner surface of the tumour protruded into the wall of the cyst without any covering by cyst wall. Since that time a large number of cases has been recorded in which cerebellar cysts have had a tumour in their walls. Many of these tumours have been called gliomas, and others angeiosarcomas on microscopic examination; but within recent years it has become clear that a large proportion are hæmangeiomas. This fact is of importance from a surgical point of view, for cerebellar hæmangeiomas are the most benign of intracranial growths, and the removal of such a tumour from the wall of a cyst should in most cases result in the cure of the patient.

In a recent monograph Lindau[2] has reviewed all the recorded cases of cerebellar cysts and has added to them a number of fresh cases, some recent, and some old specimens from museums in Scandinavia, Germany, and Czechoslovakia. He divides cerebellar cysts into six classes: (1) *Dermoid cysts and cholesteatomata;* (2) *Cysts formed as a result of hæmorrhage or softening;* (3) *Parasitic cysts;* (4) *Cysts in relation to a tumour;* (5) *Simple cysts;* (6) *Cysts in communication with the 4th ventricle.* To make the subject complete from a surgical standpoint we might add to these classes two forms of extracerebellar cyst, viz., cystic acoustic nerve tumours, and meningeal cysts caused by arachnoid adhesions. It is our present purpose to consider Lindau's Class 4, i.e., cysts in relation to a tumour, and to discuss whether his Class 5 exists, i.e., whether simple cysts may arise as a developmental anomaly apart from tumour growth.

It is quite impossible in reviewing the literature of cysts in relation to a tumour to say how many of these tumours are angeiomas and how many are gliomas. There is no doubt, however, that these two forms of growth are those most commonly responsible for intracerebellar cysts. It is not possible in many cases to distinguish with the naked eye between these two forms, nor is it possible in reviewing the literature to say how many of the recorded tumours should be allocated to either class. We might be tempted to accept the microscopical diagnosis attached to each tumour were it not for the fact that in some instances the histological appearance revealed by the illustrations is quite at variance with the diagnosis given. It is to be noted also that the term ' angeioma ' does not appear in the literature of the subject until 1923. While we cannot say definitely that angeiomas are the commonest form of tumour in relation to cerebellar cysts, our own experience suggests that they are. In a recent paper Dandy[3] reports seven cases of angeiomatous cerebellar

cysts, and expresses the view that in his operative experience they occur about as frequently as gliomatous cysts of the cerebellum.

Lindau has found 16 angeiomas and 8 gliomas in relation to cerebellar cysts. Our collection at the National Hospital, Queen Square, since the year 1914, includes 7 angeiomatous cysts (one bilateral) and 2 gliomatous cysts. These figures suggest that angeiomatous cysts are at least twice as common as gliomatous cysts in the cerebellum. In addition, both Lindau and we ourselves have found solid rounded angeiomas occurring as multiple growths in relation to the cerebellum and pons. These tumours have an identical structure to those in the wall of cysts and must be considered along with them.

An interesting point which has been brought to light by Lindau in relation to angeiomas of the cerebellum is the frequency with which they are associated with angeiomas or angeiomatous cysts elsewhere in the body. Angeiomatosis of the retina was present in two of his cases,* and has been seen also by Cushing and Bailey[4] and by Seidel[10] in cases of cerebellar cysts.† In other cases angeiomas of the spinal cord or medulla, cysts of the pancreas, hypernephromas, cavernous angeioma of the liver, or cystic kidneys have been found in patients who have died as a result of angeiomatous cysts of the cerebellum. This combination of cystic tumour of the cerebellum with angeiomas or cysts in other organs clearly demonstrates the congenital nature of the tumours. We have not been able to confirm Lindau's observations in this matter, possibly owing to the partial nature of the post-mortem examination allowed in our cases. It may however be said definitely that in none of our seven cases was an angeioma of the retina visible on ophthalmoscopic examination.

CASE HISTORIES.

Case 1.—(This case was reported in *Brain*, 1919, as an atypical endothelioma.[5])

W. B., a soldier, age 31, was admitted to the National Hospital, Queen Square, in April, 1918. He had, for about six months, been feeling giddy, especially during the morning parades. For three months he had also had severe headaches and his sight had been failing. His speech had become of a staccato character. He gave a history that a brother and a sister had 'died of the same thing' at the ages of 27 and 26.

ON EXAMINATION.—Except for an unsteady gait, he presented very slight signs of cerebellar disease. There was no nystagmus, and his co-ordination was nearly perfect, but on alternate movements his right arm and leg were slightly clumsier than the left. There was no alteration of the reflexes or of sensibility. Lumbar puncture gave a clear fluid containing 0·15 per cent protein, but no cells. The Wassermann reaction was negative in the blood and cerebrospinal fluid. He became gradually worse, becoming subject to fainting fits, in one of which he died three months after admission.

AUTOPSY.—A post-mortem was made and the brain fixed in formalin before it was examined by us. On hemisection of the fixed brain in the sagittal plane, an irregularly shaped cavity was seen lined with a thick yellow membrane which was easily detachable from the brain substance. This cavity ran from the roof of the fourth ventricle up behind the mid-brain to the pineal body, from which it was separated by a layer of pia mater. As it passed downwards to the upper surface

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* In one it could only be seen on microscopical examination.

† A similar case in which the patient and two other members of his family suffered from angeiomatosis retinæ has been reported by Rochat (*Klin. Monatsbl. f. Augenheilk.*, 1927, lxxviii, 601).

of the cerebellum it became embedded 4 mm. below the surface. It passed rather higher on the left side of the brain-stem, reaching the left corpus geniculatum internum.   On the right side it passed backwards and outwards into the upper part of the right cerebellar hemisphere.   It presented four openings in the middle line and many divarications in the substance of the cerebellum.   Its antero-posterior diameter was about 5 cm. and its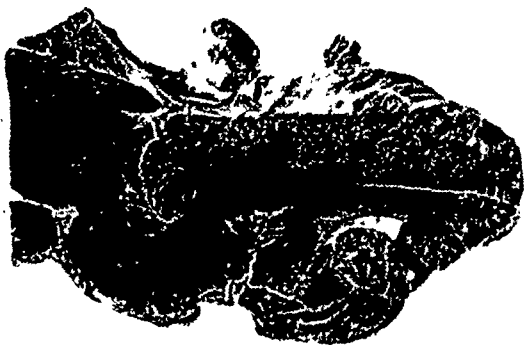 transverse diameter 3·5 cm.   A small rounded tumour was found in the left wall of this cyst. In addition there were two other tumours, one embedded in the cortex on the under surface of the cerebellum at the junction of the posterior end of the |inferior vermis with the left lateral lobe. This was a rounded reddish tumour, rather granular on its surface, and measuring 10 mm. It was surrounded on its upper surface by a small cystic space, the walls of which appeared to be formed of smooth, slightly reddened brain tissue.   A similar much smaller tumour was found on the right hemisphere near the postero-inferior surface and about 1 cm. from the mid-line. It measured 2 mm. in diameter. (*Fig.* 67.)

FIG. 67.—*Case* 1. Paramedian sagittal section of cerebellum, pons, and mid-brain, showing one tumour on the upper surface and one near the lower surface of the cerebellum. A small cyst is seen in relation to the lower tumour.

Microscopically, the larger tumour was definitely outlined by a thin zone of connective tissue, outside which the cerebellar cortex appeared to be rather compressed, but not otherwise abnormal. This connective-tissue capsule was not present around the smaller tumours. The tumours themselves consisted of a network of capillary vessels, lined by flattened endothelium between which lay larger endothelial cells with oval nuclei and scanty rather granular or foamy cytoplasm. A fine network of connective-tissue fibres reinforced the walls of the capillaries and was condensed in several concentric layers around the numerous large sinus-like spaces, which apart from this had no definite walls. In the smaller tumours some of the endothelial cells had larger bodies containing vacuoles of fairly large size, and in some areas all the cells were greatly swollen and foamy with small eccentric nuclei.

The lining membrane when examined was seen to consist of nervous tissue, in places degenerated and in other places reinforced by collagen strands. It contained numerous granules of blood-derived pigments.

This case is of special interest on account of the family history, which caused an original diagnosis of " familial cerebellar ataxia with papillœdema " to be made. It is possible, although it cannot be proved, that the brother and sister also suffered from hæmangeiomas of the cerebellum. The large cyst in the upper part of the cerebellum had been emptied before fixation and was somewhat distorted by the weight of the cerebellum which lay over it. Consequently its appearance cannot be taken as representing in any way its shape during life, when it probably formed a more or less rounded mass rising from the upper surface of the cerebellum. The tumours were otherwise typical capillary angiomas, so much so that this case was at once recalled when the tumour in *Case* 2 was seen five years later.

Case 2.—W. C., age 25, was admitted to the National Hospital, Queen Square, in December, 1922, under Dr. Kinnier Wilson. He had had, in 1918, a wound of the face by a bullet which entered just external to the left eyebrow and emerged below the lobe of the right ear. After this he felt quite well till August, 1922, when he found that on rising in the morning he felt dizzy and had a 'terrific pain' at the back of the head. These headaches became more frequent and more persistent, and he also had pain over the eyes. During the three weeks before admission vomiting had occurred with the headache on several occasions. Twice he had had a sensation on looking to the left as if objects in that direction were flickering up and down.

ON EXAMINATION.—No nystagmus could be made out, and beyond definite swelling of both optic discs, and unsteadiness in walking and on standing, there was no alteration in his physical condition. He died on Feb. 9, 1923, and a post-mortem examination was made of the brain only. No external tumour could be seen, but there was evident hydrocephalus. On section of the cerebellum a cyst was found which spread across the right half of the cerebellum from its outer edge to the white matter of the middle peduncle, and was about the size of a pigeon's egg (Fig. 68). On the outer border of this cyst a small round firm tumour was seen. It had a mottled surface and was adherent to the cerebellar cortex.

FIG. 68.—*Case 2.* Horizontal section of cerebellum looked at from below. Tumour and cyst are seen in the right hemisphere. The dentate nucleus lies close to the cyst wall.

Histologically this tumour resembled very closely those in *Case 1*; like them it contained large sinus-like spaces lined by an endothelial layer and supported by an irregularly concentric condensation of fibrous tissue. A connective-tissue capsule surrounded part of the tumour, but elsewhere this was absent. The tumour had, however, everywhere a very definite margin, as the capillary loops of which its edge was composed ceased along a curved line. Near the inner margin of the tumour was a small cyst containing clear, colloid material. The outer wall of this cyst was formed by a thick zone of connective-tissue fibres, but its inner wall—that is, the wall towards the centre of the tumour—was simply formed of tumour tissue. With Scharlach R. staining almost every one of the larger endothelial cells in the tumour was seen to contain a mass of fatty granules, a few of which had small anisotropic specks among them.

This case was in every way typical. The interval of four years between the wound and the onset of symptoms makes the connection between the trauma and the beginning of the cyst formation rather indefinite. But in view of the close relationship which existed in our *Case 5* between the injury to the head and the onset of symptoms, the possibility of a similar relationship in this case must be borne in mind.

Case 3.—Rose W., age 33, was admitted to the National Hospital, Queen Square, under Dr. Grainger Stewart on Sept. 20, 1926. She had suffered for four months from occipital headaches and vomiting, which had been coming on in the morning with increasing severity. She had at times seen double, but not constantly. Her walking had become unsteady and she felt giddy almost all day. Recently her sight had failed considerably, and she had not been able to write properly for six weeks.

ON EXAMINATION.—It was found that she was rather slow-witted and lethargic. Her memory, however, was good and her speech normal. There was severe papillœdema on both sides with hæmorrhages into the surrounding retina. Her visual acuity was 6/6, but the fields of vision were somewhat restricted. When she looked to the extreme left she had diplopia and a few nystagmoid jerkings were seen, scarcely meriting the name of nystagmus.

FIG. 69.—*Case* 3. Section of the tumour showing large blood spaces, and a few large darkly staining nuclei.

There appeared to be slight weakness of the right side of the face, and her head was turned slightly to the right with the chin tilted in the same direction. Sensibility to all forms of stimuli was perfect, and the voluntary power of all limbs was good. There was, however, some loss of tone in the left arm and inco-ordination of both arms, especially the left. Some inco-ordination of movement was also present in the legs. The reflexes were normal. A decompression operation over the posterior cranial fossa was performed a week after admission. The patient died on the same day.

AUTOPSY.—At the post-mortem a smooth-walled cyst containing clear yellowish fluid was found in the right cerebellar hemisphere near the postero-internal surface. It could be seen from the surface through the thin and translucent cortex. Microscopically it was found to have no lining membrane, the wall being formed by a very slight neuroglial condensation. Elsewhere the cerebellar tissue looked normal.

There was a dimple-like depression in the postero-inferior wall, and on section through this a very small rounded knot of tumour tissue about the size of a lentil was found. This proved to be a capillary angeioma, almost exactly similar in histological structure to those already described. There was, however, no definite connective-tissue capsule round it. It contained some large sinus-like spaces with no definite wall except an endothelial layer based on the thin walls of the surrounding capillaries. Many of the endothelial cells lying between the capillaries had large, darkly staining, elongated nuclei, and others contained a clump of several rounded nuclei. Both these appearances were interpreted as degenerative types of cell. (*Fig.* 69.)

Case 4.—Zillah J., age 30, was admitted to the National Hospital, Queen Square, under Dr. Adie, on Aug. 21, 1926. For about a year she had had severe pain in the top of the head whenever she bent down, but, except for this, had had no headache until the last two months. About Easter, 1926, a grinding noise in the left ear had come on and persisted for four months. For the last two months the pain in her head had been more severe and had come on frequently in the morning

on·waking. She also began to have attacks of giddiness when walking in the street and occasionally felt faint. For the last five weeks she began to have pain also· in the back of the neck. Her eyesight had become misty, and she often saw double. She had had occasional attacks in which she felt faint, but had never actually lost consciousness.

ON EXAMINATION.—She appeared to be well and cheerful. She carried her head turned slightly to the right and tilted slightly backwards. She complained of pain and stiffness in the neck, but there was no limitation of movement of the head. Severe papillœdema was present in both eyes. Very slight, fine, and rapid nystagmus was present on deviation of the eyes to the right, and a few arrhythmic jerks occurred on deviation to the left. There was hypotonia and inco-ordination of both arms and legs, most pronounced on the left side. The reflexes were normal.

A craniotomy over the left cerebellar hemisphere was performed on Sept. 3, by Mr. Donald Armour, and a large cyst in the left lateral lobe of the cerebellum was found and emptied. After this operation she was very much better and remained fairly well during 1927. But in March, 1928, her walking again became unsteady and her speech hesitant and snuffling. Headaches also became more frequent.

She was re-admitted to the National Hospital on June 13, 1928.

ON EXAMINATION.—Her optic discs were found to be pale and slightly cupped. Her vision was fair, 6/12 right and left. Her external ocular movements were full, but there was nystagmus on turning the eyes to either side. Both arms, but especially the left, were atonic and ataxic. There was loss of tone also in the legs, and ataxia of the left leg. Sensibility, motor power and reflex functions were unimpaired. Her gait was very ataxic and reeling. There was a tense hernia at the site of the previous craniotomy.

A second operation was performed on June 20, at which a cyst was tapped in each cerebellar hemisphere. The patient died three days later.

AUTOPSY.—At the post-mortem a fairly large cyst was present in the left cerebellar hemisphere and a smaller cyst in the right. That in the right hemisphere passed forwards to the outer aspect of the dentate nucleus, while that in the left reached to about 4 mm. from the roof of the 4th ventricle internal to the dentate nucleus. It was bounded internally by the mid-line of the cerebellum. On careful examination of the cyst walls, which were otherwise smooth and colourless, a small dimple was found in the postero-external wall of each cyst, and at the bottom of this a small rounded reddish tumour was found. That in the right hemisphere measured 7 by 4 mm.; that in the left hemisphere 4 by 2 mm.

FIG. 70.—*Case* 4. Section of edge of tumour. Capillary loops are seen passing into normal neuroglial tissue.

Histologically these tumours were capillary angeiomas and resembled very closely those already described. They were entirely without any connective-tissue capsule; their edges, however, were fairly sharply defined. the capillary loops of which the tumour was formed ceasing along a regular line (*Fig.* 70). The larger tumour was unusual in that it surrounded and apparently enclosed an area of nervous tissue. which showed signs of degeneration but was easily recognizable as cerebellar cortex.
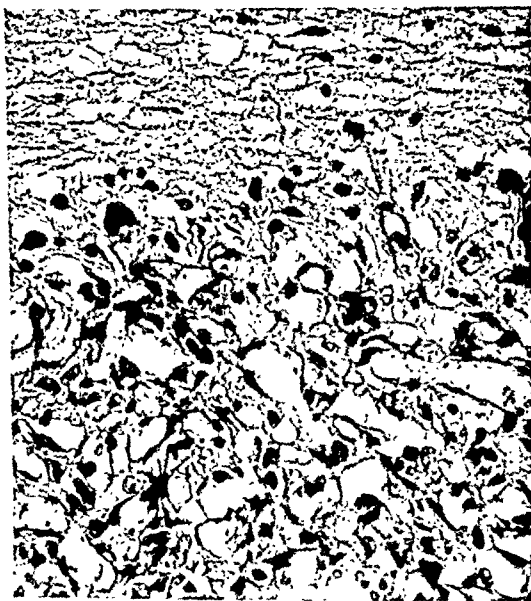
It was not possible to tell whether this piece of cortex was completely surrounded by tumour, as it was impossible to make serial sections through the whole thickness of the tumour. Throughout the larger tumour the connective-tissue septa were rather thicker than in the others, but otherwise the histological differences were very slight. Foamy cells were abundant (*Fig.* 71), and many large multinucleated giant cells were also seen between the capillaries. The walls of the cysts consisted of condensed neuroglial fibres, among which were many swollen neuroglia cells.
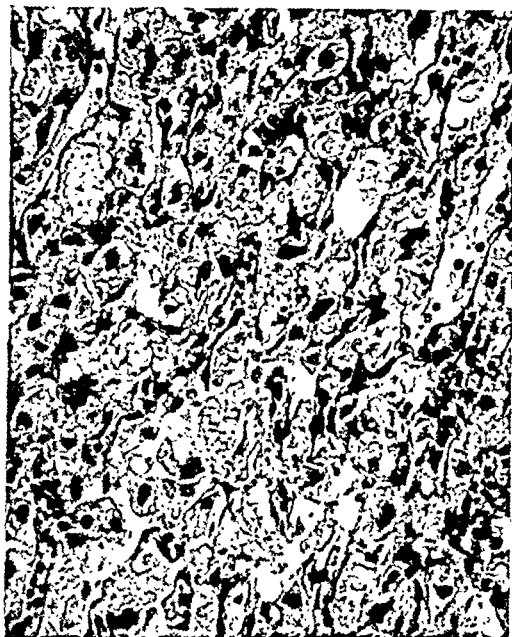

FIG. 71.—*Case* 4. Section of the tumour showing numerous large foamy cells.

Case 5.—John A., age 57, was admitted to the National Hospital, Queen Square, under the care of Dr. Kinnier Wilson, on June 22, 1928. About a year before he had slipped and fallen on the back of his head. He was dazed but not unconscious at the time, and felt no severe after-effects. But three months before admission he began to suffer from occipital headaches. About 10 days before admission he began to have attacks of vomiting, and later had had a buzzing noise in his ears. During the last week he had become weak on his legs and was no longer able to stand alone. His vision had become blurred, but he had never seen double.

ON EXAMINATION.—The patient was drowsy and slow-witted. There was no swelling of the optic discs nor true nystagmus. There was some reduction of sensibility to pinprick on the area of the face supplied by the 2nd and 3rd divisions of the right trigeminal nerve, and some weakness of the lower half of the right side of the face. Voluntary movements of the arms and legs were performed slowly and deliberately, but there was no weakness or ataxia. There was no alteration of sensibility or of the deep or superficial reflexes.

A cerebral decompression was performed by Mr. Donald Armour on July 10, but the patient only survived for a few hours.

AUTOPSY.—The post-mortem revealed a large pressure cone of cerebellum which reached far down through the foramen magnum on the left side. A cyst was found on the under surface of the left cerebellar hemisphere which ruptured as the brain was being removed from the skull. The lateral and third ventricles were considerably dilated. On section (*Fig.* 72) after hardening, this cyst measured 4 × 3 cm. in its horizontal diameter and was about 2 cm. deep. It lay external to the dentate nucleus, which was compressed inwards and forwards, and it had thinned out the cortex of the outer and lower part of the hemisphere. At its outer and inferior pole was a reddish oval tumour which measured 10 × 7 × 5 mm. On cross-section the centre was more yellow than the surface. The upper surface of the tumour lay free in the cyst, the lower surface embedded in the cortex.

Histologically (*Fig.* 73) the tumour was a capillary angeioma, very similar to the others described. The large sinus-like spaces were walled by a condensation of the connective tissue which formed the frame-work of the tumour, but minute capillaries could be seen throughout this wall and were even found in its innermost layers. Almost all the endothelial cells lying between the capillaries were honeycombed with spaces which with Scharlach R. staining were seen to contain globules of fat.

FIG. 72.—*Case 5.* Horizontal section of cerebellum and pons viewed from above.
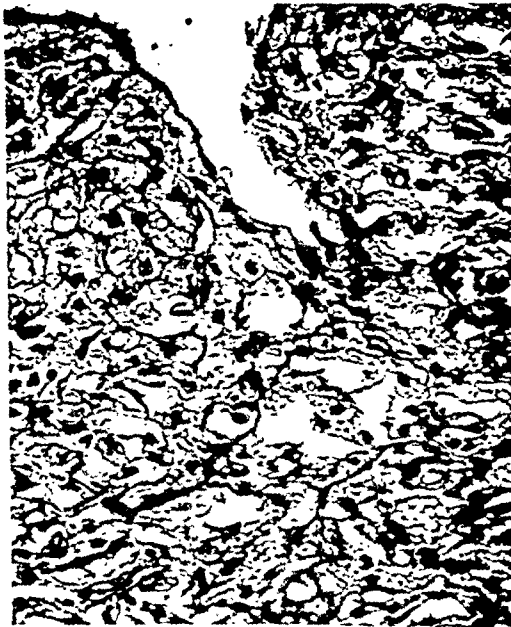

FIG. 73.—*Case 5.* Section showing numerous foamy cells and a large sinus-like space.

Indeed, the amount of fat in the tumour was astonishing. It was present as droplets of varying size, almost all of which appeared to consist of neutral fat, as very little of the red-staining substance was anisotropic. But here and there in the centre of a mass of red globules, *minute dots or rods of doubly refractile substance could be seen.* The tumour had a very thin but definite capsule of fine connective-tissue strands. The wall of the cyst consisted of condensed neuroglia fibres, and no lining membrane was present.

Case 6.—J. P., male, age 56. Under the care of Sir Farquhar Buzzard.

This patient was a hard-working, highly intellectual man of good physique, and healthy in every way. In the spring of 1925 he felt very tired and went to Italy for a holiday. Whilst there he was trying to lift a little girl when he lost his balance and fell ; he was not hurt, but shaken. At times after that he found himself unsteady on his legs, but not giddy. Occasionally suffered from sharp shooting pains in the back of the head. About December, 1925, he began to have attacks of morning sickness, with occasional transient partial amaurosis. He had also noticed a tendency to deviate to the right in walking.

ON EXAMINATION.—There was some lateral nystagmus, rather more to the right than to the left. Although right-handed, the right grasp was weaker than the left. The left abdominal reflex was less marked than the right ; the left plantar reflex indefinite and the right flexor ; the left knee-jerk brisker than the right. The optic discs showed a moderate degree of papilloedema.

On Jan. 23, 1926, a bilateral cerebellar decompression was performed by one of us. A cyst was found in the right hemisphere containing about an ounce of yellow fluid, which clotted readily. It was thought to be a degenerated gliomatous cyst, as no solid tumour was detected. The pressure having been fully relieved, the wound was closed. The patient made a complete and uninterrupted recovery, and returned to his very responsible official work, perfectly fit, in April.

When he left the Nursing Home the optic discs presented a normal appearance, and the nystagmus had disappeared.

He remained quite well until July, 1928, when morning sickness re-commenced, and he felt weak in the limbs. There was no severe headache. When reading he noticed a little blurring of vision.

ON EXAMINATION.—There was some lateral nystagmus to the right ; no papilloedema, but some engorgement of the veins. The flap bulged a little and was somewhat tense. Aspiration failed to withdraw more than a few drops of fluid. In July a second operation was performed. The flap was turned down, and a small solid tumour, apparently quite definitely circumscribed, was easily removed from within the right cerebellar hemisphere. No trace of a cyst could be detected. The patient recovered even more quickly than after the previous operation, and is now quite well and back at work.

The tumour was a *solid reddish* mass, oval and somewhat lobulated, but more or less rounded in outline (*Fig.* 74). On its inner surface it appeared to be covered by a thin capsule, while on its outer surface there was a thin layer of cerebellar cortex, which could be separated

FIG. 74.—*Case* 6. Naked-eye appearances of the tumour, external surface and cross section. (*Actual size.*)

from the tumour without much difficulty. The tumour measured 3·5 × 2 × 1·8 cm. and weighed 5 grm. On section the cut surface was of a *deeper pink colour* than the capsule. It looked fleshy and vascular, with several large spaces or channels opening on it, but no blood escaped from these on pressure, nor was coagulated blood visible in them.

Histologically it was very similar to the other angeiomas, especially to that in *Case* 3, in that it contained many very large endothelial cells with irregular nuclei

which seemed to be undergoing degeneration. When stained with Scharlach R. localized accumulation of fatty globules was seen filling one, two, or more neighbouring cells. The rest of the tissue was almost free from fat, but in many of the cells two or three minute fatty granules could be seen with the higher powers of the microscope. The lipoid in the larger collections was much more diffusely anisotropic than in the other tumours examined in this way.

Case 7.—Henry R., age 41, was admitted under Dr. Riddoch to the National Hospital, Queen Square, on March 27, 1925. Eighteen months before admission he had ricked his neck when tying his tie, and thereafter he could not lie on his left side in bed without pain in the neck. Six months later he found that stooping forwards caused severe pain in the back of the head and neck, and lying on the right side in bed also brought on this pain. It became more severe during the following six months, and in November, 1924, he complained of a swimming feeling in his head. He commenced to stagger and sometimes fell, usually to the left side or forwards. He also had at this time transient diplopia in the mornings. In January, 1925, he began to vomit, and the headache became so severe that he sometimes screamed with pain. Towards the end of this month he began to be drowsy. In February he had periods of aphonia or hoarseness in which his voice would leave him for an hour or two. The headache and staggering became much worse, and one day he was semi-comatose.

The patient's family history was uneventful. His parents were both alive. He himself was the eldest of ten children, two of whom died in childhood. One brother was killed in the war ; another had had fits since the age of 13, and a sister was subject to headaches. His own health had been good except for influenza in 1918 and a blow on the chest from the shaft of a cart in 1924. He had never been able to raise his left eyebrow since birth.

On Examination.—There was slight swelling of both optic discs, but good vision and no limitation of the fields. Diplopia was present on looking to the left owing to weakness of the left external rectus muscle. There was no nystagmus. Slight weakness of the lower part of the left side of the face was present. There was no inco-ordination of the arms or legs, but his gait was very unsteady and he could not stand steadily with his feet together and his eyes shut. There was no alteration in the deep or superficial reflexes. Apart from a rounded kyphosis in the upper dorsal region, his spine appeared to be normal, but movements of the neck caused pain.

An operation (left-sided subtentorial craniectomy) was performed by one of us on April 17, 1925. On exposure of the cerebellum the left lobe protruded somewhat more than the right, and was more resilient. It was split transversely, and a cyst was found lying near the middle line but not involving the dentate nucleus. It appeared to extend into the right cerebellar hemisphere, and towards the surface of the cerebellum on its left side. It was tapped, and about 2 oz. of yellowish fluid was removed. No evidence of a tumour was seen at this operation. The patient made an uneventful recovery and left the hospital on May 8, 1925. He improved steadily for over a year, and then began to have headaches, dysarthria, and unsteadiness in walking.

The cyst was again tapped in November and December, 1926. In January, 1927, he had more severe headaches and felt sick in the morning. His gait became unsteady and he had occasional diplopia and dysarthria.

The cyst was tapped for the fourth time in April, 1927, and some clear yellow fluid removed which contained about 4 per cent of protein and 2 cells per c.mm.

In November, 1927, some more fluid identical with that obtained at the previous operation was removed. Two further tappings were done during 1928. After each tapping the symptoms were immediately relieved ; but after varying intervals of time they gradually recurred, and further operative measures were decided upon.

In January, 1929, the patient was suffering from severe headaches and vomiting, and the hernia cerebelli was very prominent and tense. There was marked dysarthria, with hypotonia of the left limbs. He walked fairly well, but tended to

fall to the left. There was a moderate degree of papillœdema. Very slight nystagmus could be detected on extreme lateral deviation of the eyes.

The second operation was performed on Jan. 11, 1929, when a solid tumour was easily removed from the interior of the thinned out, semi-translucent left cerebellar hemisphere (Fig. 75). No cyst wall was seen. The most superficial part of the tumour was close to the back of the petrous bone, but not so far forward as the internal auditory meatus. Recovery was rapid and uneventful, and the patient left the hospital at the end of three weeks, greatly improved in every way, and with no cerebellar bulge.
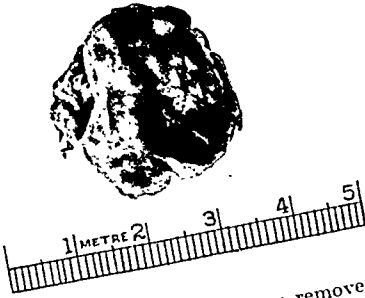
The tumour was more or less oval, but very lobulated and irregular on the surface. It was reddish yellow in colour. Its outer surface was smooth and glistening, and where it was attached to shreds of cerebellar tissue it was quite definite from these. There was, however, no limited tumour capsule. It weighed 6·5 grm. and measured 2·5 × 2 × 2 cm. On cross-section it resembled a sponge, as it contained smooth-walled cavities of all sizes, ranging from those scarcely visible to the naked eye to those with a diameter of several millimetres. Some of the latter were obviously dilated blood-channels, but others were empty. The cut surface appeared compact parts than the outer surface of the

FIG. 75.—Case 7. Tumour removed.
(Slightly less than natural size.)

rather more yellow in the more tumour.

Histologically it was a typical plexiform angeioma with very numerous, interlacing blood-channels of all sizes, from capillaries to fair-sized arteries and veins and sinus-like spaces. The capillaries and sinuses were supported by a very thin connective-tissue layer. Between these blood-channels there were numerous foamy cells, apparently of endothelial nature. With Scharlach R. the majority of these cells were found to be filled with lipoid globules, some apparently being fat and others doubly refractile cholesterin compounds including many myelin crosses. These foamy cells in some parts of the tumour were very numerous, and here and there formed aggregated masses. In other parts little could be seen except blood-channels; but the general structure of the tumour did not vary greatly from one part to another. Near one edge an included area of cerebellar tissue was present. This tumour contained considerably more lipoid than most of the others, and the amount of myelin and other doubly refractile lipoid was especially large.

The following case is added as the tumour was of the same nature, but it appeared to grow from the dorsal surface of the medulla, and it was not associated with a cerebellar cyst.

Case 8.—Elsie R., age 20, was admitted to the National Hospital, Queen Square, under Dr. Riddoch, on Jan. 4, 1929. She had suffered from morning headaches for four years. At first she had frequently vomited with the headache, but recently had not been so much troubled with this. In July, 1926, the headaches became again so severe that she had to give up work. About the beginning of 1928 she began to feel giddy in the mornings, and in September she began to have occasional 'fainting spells'.

During the past year she had had attacks of a tingling sensation in the left arm extending up to the left side of the face. Occasionally she had felt this sensation in both sides of the face. It tended to come on when she was tired. She had also become unsteady and weak in her legs. Since July she had usually felt ill in the morning, but improved later in the day. In December, 1928, her vision became blurred. This was at first transient, but recently had become constant. Her father and mother and her only brother were alive and well.

ON EXAMINATION.—The patient was an intelligent girl but rather slow-witted. She lay in bed with her head turned to the right and raised on a pillow, and said that any other position of the head brought on a feeling of dizziness. Her vision was very poor ; with the right eye she could only distinguish light from darkness ; with the left eye her vision was 3/50. Papillœdema was present in both eyes, with 5 dioptres of swelling and some retinal hæmorrhages in the right eye. The right pupil was rather larger than the left, and the right external rectus muscle was paralysed, causing strabismus on looking to the right. There was no nystagmus. There was some general weakness, hypotonia, and inco-ordination in both arms and legs. All the deep reflexes, with the exception of the biceps-jerks, were absent. The superficial reflexes were present, the plantars being of the normal flexor character. In walking and standing she held her head bent forward and to the right, and the right shoulder a little lower than the left. Her gait was unsteady and ataxic, and she tended to fall to the right. She died shortly after a cere-bellar craniotomy by one of us.

AUTOPSY.—A post-mortem, limited to the head, was made sixteen hours after death. There was a pressure cone of moderate size in the foramen magnum, and between the lips of the tonsils which formed this cone a reddish vascular tumour, resembling choroid plexus, could be seen protrud-ing in the region of the fora-men of Magendie. The whole medulla was swollen and very soft, and the olivary emin-ences were unduly prominent. Large veins ran from the medulla towards the base of the skull ; one of these which ran over the posterior surface of the cerebellum had been ligatured. The arteries were of normal size and were other-wise healthy.

On section across the medulla in the horizontal plane it was found that all the lower half of the fourth ventricle, below the inferior limit of the pons, was filled by a pinkish-yellow, sponge-like mass of tumour which was attached

FIG. 76.—*Case* 8. Sections across medulla and cerebellum viewed from below and showing tumour *in situ.*

to the floor of the ventricle throughout its extent, but was not attached to the cerebellum where it formed the roof of the ventricle. The choroid plexus was pushed back and flattened between the tumour and the roof of the ventricle. The left foramen of Luschka was widely patent, but the right foramen was closed by adhesions round the tumour. The tumour passed out of the foramen of Magendie for a short distance. Except in so far as its shape was determined by the pressure of the ventricular walls the tumour was rounded and well defined. All over the cut surface there were large sinus-like spaces, and three large veins were seen, one at either lateral margin and one at its posterior extremity. Close to the latter was a hæmorrhagic area, probably resulting from operative trauma.

The tumour measured 2·5 cm. transversely and 3 cm. in antero-posterior diameter. It extended for about 2·5 cm. in a vertical direction. (*Fig. 76.*) The swelling of the medulla was found to be due to œdema. A small cyst had formed in the region of the right cerebellar peduncle close to the tumour, but not touching it. Apart from a considerable degree of hydrocephalus the brain was normal.

Histologically the tumour resembled the others of this series in being composed of a tangled mass of capillary vessels with numerous large endothelial cells, some of which appeared to lie within the lumen of the capillaries and some between them. The capillaries were fairly well supported with fine connective-tissue septa. Many of the endothelial cells were swollen and foamy in appearance, and with Scharlach R. staining were seen to be full of fat granules, but the number of such cells was not so great as in some of the other tumours, nor was any of the lipoid doubly refractile. Numerous larger blood-vessels of all sizes, with fairly well-formed coats of connective tissue were present. In a few of the largest of these there was also a thin muscular coat. Very thin-walled blood sinuses of fairly small size were also seen. There was evidence of neuroglial hyperplasia and some overgrowth of fibrous tissue in the layers of the medulla touching the tumour. Elsewhere the medulla was very œdematous, but otherwise healthy.

DISCUSSION.

These cases, although few in number, are very representative of those in the literature. Although more than one cyst and one tumour is rare, we have had one case of bilateral angeiomatous cysts, and one of multiple tumours, two of which were related to cysts. The bilateral cysts were at first mistaken for simple cysts, until at a later examination a minute tumour was found in relation to each of them. Our series also includes as small and as large tumours of this kind as are usually found.

CHARACTERS OF THE TUMOURS.

The appearance of the tumours is typical and characteristic. They are rounded, and sharply demarcated from the cerebellar tissue. In colour they are pinkish or often somewhat yellow, apparently from the accumulation in many of the cells of a yellowish fatty substance, or possibly from the presence in the cells of altered blood. Small cavities, some of them obviously blood-vessels, are often visible to the naked eye on cut section, but in others the tumour has a more uniform appearance. In colour and consistence they are always quite definitely demarcated from the white matter, although it is not always so easy to make out the line of junction with the cerebellar cortex. In position they affect most frequently the posterior wall of the cysts, and lie either touching, or embedded in, the cerebellar cortex. Many writers, from Hughlings Jackson onwards, refer to their contiguity to the pia mater. In our experience, and in that of Lindau, they always touch the grey matter.

In size they vary from 2 mm. to 2 cm., rarely more. Our specimen (*Case* 6) removed at operation is as large as any that has been seen. Most writers refer to them as of the size of a pea, a bean, a cherry-stone, or an almond. This size bears no relation to the size of the cyst, and large tumours may be related to small cysts (*Case* 1) or large cysts to minute tumours (*Case* 4).

In microscopic characters they agree exactly with Ewing's[6] description of plexiform angeiomas. In some the vascular nature of the tumour is obvious, as it is formed of a mass of capillary vessels lined with endothelium, running

in a groundwork of collagenous fibrous tissue. In such tumours there are, in addition, larger vessels, the majority of which are sinus-like with thin walls. But even in these tumours, which represent the simplest form of angeioma, the endothelial cells lining the capillaries tend to swell and, breaking away from the connective-tissue substratum, lie free in the lumen of the capillary. Some of the capillaries are filled, and apparently blocked, by cells of this kind, and contain no blood. In addition there is a tendency for the endothelial cells to proliferate in the stroma of the tumour, and here they may form fairly large multinucleated cells, or may accumulate lipoid in their cytoplasm, becoming vacuolated in appearance. Lindau emphasizes this peculiarity as distinguishing the cerebellar angeiomas from those found elsewhere in the body. When stained with Sudan or Scharlach a large number of the cells are found to be filled with fatty granules, some of which are doubly refractile.

Other tumours are much more cellular, and the connective-tissue groundwork is very scanty. These tumours resemble cellular endotheliomas, in which capillary vessels are formed between the tumour cells. Between these extreme types all possible variants are found, and often one part of a tumour will resemble one extreme and another the opposite extreme. But between even the extremes there exists a striking family likeness, and it is impossible for a histologist who has seen one of these tumours to fail to recognize another. It is therefore remarkable that so much diversity of nomenclature exists in the literature.

The character of the cyst wall is important. In the majority of cases it consists simply of sclerosed neuroglial tissue, with overgrowth of fibres and few nuclei. Swollen neuroglia cells are sometimes seen, but there is never any resemblance to gliomatous tissue. Usually there is no lining membrane or epithelial covering, but occasionally a few cells resembling endothelium are seen on the wall. In some cases a definite lining membrane has been described, and one of the cysts in our *Case* 1 was lined by such a membrane in which granules of hæmatoidin and hæmosiderin were found, giving evidence of previous hæmorrhage into the cyst. Usually, however, the wall does not differ in colour from the white matter of the cerebellum. The character of the lining membrane when it is present and the normal character of the neuroglial tissue surrounding the cyst make any attempt to remove the cyst wall unnecessary.

It is remarkable with what constancy the dentate nucleus is spared. It is often pushed aside and may be flattened by the pressure inside the cyst, but neither in our cases nor in those previously described is it ever either destroyed or broken into by the enlargement of the cyst. This is all the more remarkable if we consider the size of the cysts and the way in which they thin out the cerebellar cortex : but it is an encouraging fact to bear in mind, as the experience of the war showed that complete clinical recovery might follow lesions of the cerebellar hemispheres if the dentate nucleus was intact (Holmes[7]). Ernest Sachs[8] relates how one of his patients, one month after the removal of the tumour from the wall of a cerebellar cyst, went for a three-mile walk. In this case the cyst had on several occasions been emptied, either by open operation or by puncture. with only temporary relief. When seen three years after the last operation the patient was still perfectly well.

MODE OF GROWTH OF THE TUMOURS AND CYSTS.

According to Ewing and most other authorities, capillary angeiomas are of congenital origin. It seems likely, however, that they may grow at the expense of the tissues round them. The appearance of the edge of the tumour in our cases suggests a continued outgrowth into the cerebellum. In our Cases 6 and 7 it is unlikely that the tumour would have been overlooked at the first operation if it had been as large then as when it was removed. If growth does take place at the expense of the cerebellar tissue, this would explain the amount of fat seen in the larger endothelial cells of the tumours. The character of the fatty inclusions, especially the presence of anisotropic particles in the fat globules, agrees well with its possible origin from broken-down myelin.

The symptoms in most cases, however, appear to be due rather to the increase in the size of the cysts than in that of the tumours. Two possibl origins have been suggested for the cysts : (1) That they are formed by the degeneration and liquefaction of the tumours ; and (2) That they are caused by the seeping of plasma from the vascular tumours. We can say quite definitely that, at any rate in so far as angeiomatous cysts are concerned, they do not arise in the first manner. The rounded shape of the tumours, and the complete absence of any tumour tissue from other parts of the cyst wall, completely negative this possibility. Gliomatous cysts may arise to some extent from the degeneration of the tumours ; but where the tumour is minute and the cyst large, as in Williamson's[9] first case, the theory which he put forward in 1892, that all except a small knot of tumour had degen-erated, appears to us in the light of our present knowledge quite untenable.

The second suggestion as to their origin seems much more reason-able. We cannot be certain how the formation of the cyst began, but the history of trauma given by two of our patients, as also by the patient of Cushing and Bailey, and by both the brothers whose cases Seidel[10] reported, is very suggestive. In our two oldest patients, as in Seidel's patient, symptoms of intracranial pressure came on about six months after a fall which was not severe enough to cause any very bad immediate symptoms. In Cushing and Bailey's case the evidence of hæmorrhage from the angeioma at the time of the injury was more direct, as neck rigidity and occipital headache came on at once, and lumbar puncture gave a blood-stained fluid ; symptoms of intra-cranial pressure were, however, deferred for three years. In our second case symptoms referable to the cerebellar cyst came on four years after a wound by a bullet which passed through the face from side to side and must have jarred the skull. The evidence of direct etiological connection between the injury and the cyst formation is therefore in this case slender enough, although it is fairly definite in the older cases. Traumatic cysts are known to occur in the cerebellum as well as in the cerebral hemispheres, and when a small angeioma is already present probably no great degree of trauma is needed to cause slight hæmorrhage or œdema round it. Once the formation of a cyst has begun, it is likely to increase in size as the vascular tumour in its wall exudes plasma into it. The character of the cyst wall suggests that the increase in size is slow, as the neuroglial cells and fibres are usually of an adult type,

and there is no evidence of recent tearing or disintegration of the tissues round the cyst. In fact, the cyst walls are always smooth, and one is surprised to find that they are not lined by an endothelial layer.

FAMILIAL INCIDENCE.

Our first patient gave a history that a brother and a sister had ' died of the same thing '. It was impossible, owing to the war conditions which then obtained, to confirm this history, and of itself it would be of little value. On reviewing the literature we find, however, that a familial incidence of this affection is not very uncommon. Reference has already been made to Seidel's case. The patient's brother who, like himself, was a tight-rope dancer, had shown signs of cerebellar tumour soon after a fall from his rope ; he had been operated on and a cerebellar cyst found. Seidel's patient had, in addition to a cerebellar cyst, a hæmangeioma of the retina. In the case reported by Cushing and Bailey, in which a retinal angioma was present in addition to the cerebellar growth, the patient's father and paternal aunt had both died from ' cystic sarcomas of the brain '. Lindau recorded, in 1927, a further case of angioma of the retina with cystic hæmangeioma of the cerebellum, cystic kidneys and pancreas, and hypernephromata in the kidneys and epididymis. The patient's brother had died from what was presumed to be a cerebellar tumour.

No doubt careful inquiry would reveal other familial cases. It is not indeed remarkable that a disease which, like this, is based on a congenital maldevelopment dating back, as Lindau considers, to the third month of foetal life, should show a tendency to affect more than one member of a family. The fact of familial incidence is, however, of great clinical value, as a history of this kind in a case of intracerebellar tumour would be strong presumptive evidence that we were dealing with a cystic hæmangeioma. Familial cases of eighth-nerve tumour are known, but are very rare ; and gliomatous tumours practically never affect more than one member of a family.

The presumptive evidence given by a family history of cerebellar tumour is, however, much less definite and certain than the presence of a retinal hæmangeioma in the patient himself. This in a case with cerebellar symptoms is practically pathognomonic of hæmangeiomatous cyst of the cerebellum, although the tumour might lie in some closely related part of the brain-stem, such as the pons or medulla. Cushing and Bailey have found in their very numerous records no case of hæmangeiomatous cyst above the tentorium, nor in fact elsewhere than in the cerebellum. But similar tumours have been found in the brain-stem and cord by other observers, and in the latter situation have sometimes been related to cysts.

DISTINCTION OF ANGEIOMATOUS CYSTS FROM GLIOMATOUS CYSTS.

It is not always easy to tell from a naked-eye examination whether a cyst is due to an angioma or to a glioma, as some gliomatous cysts resemble very closely those we have been describing. Many, however, are easily distinguished by their irregular or multilocular shape, by the presence of trabeculæ passing

from one wall to another, and by the obvious presence of tumour tissue in more than one part of their walls. Angeiomatous cysts are so constantly rounded and smooth-walled that any departure from this appearance should suggest the presence of a glioma.

It is usually not difficult to distinguish an angeioma from a glioma when a knot of tumour tissue is found in the wall. The reddish-yellow colour of the cut surface of the angeioma, its clearly-defined rounded outline, and the presence in it of multiple minute cavities distinguish it fairly readily from a gliomatous nodule, which, apart from obvious hæmorrhages, is usually whiter and smoother, and merges more gradually into the surrounding brain tissue.

The apparent presence of a lining membrane is of equivocal value as a distinguishing mark. Such an appearance is usually merely the result of hæmorrhage into the cyst which has stained the inner layers of the walls, a condition which may be found in either form. As we have seen, removal of such a lining membrane is as unnecessary in the case of an angeiomatous cyst as it is likely to be ineffectual in the case of a gliomatous cyst.

THE QUESTION OF SIMPLE CYSTS OF THE CEREBELLUM.

Lindau records two cases of what appear to be simple cysts of the cerebellum. Both were museum specimens, and in neither was the wall of the cyst complete, so that it is possible that a small tumour existed in the part of the wall which had been removed. In one of the cases the cyst resembled an angeiomatous cyst in lying in one cerebellar hemisphere and in pushing the dentate nucleus aside without destroying it. In the other case the cyst lay in the mid-line under the vermis, which is an unusual situation for an angeiomatous cyst. The possibility of a minute tumour causing a large cyst, as in our *Case* 4, and in a case recorded by Williamson, makes us doubtful about the existence of simple developmental cysts of the cerebellum. One of the tumours in our *Case* 4 was so small and—lying in a dimple in the wall of the cyst—was so hidden from sight that it was at first overlooked. In one of Williamson's cases the tumour was very minute, measuring only 2·5 × 4 mm., in a cyst the size of a pigeon's egg. Certainly it is the duty of the surgeon, when he encounters a cyst in the cerebellar hemisphere, to search carefully for the tumour, or if it is not apparent, to remove the tissue round any dimple that may be seen projecting into the cerebellar cortex. Our *Cases* 6 and 7, and the case of Sachs which we have quoted, suggest that by doing so the patient may be saved from a recurrence of symptoms and a second operation.

CONCLUSIONS.

1. The majority of cerebellar cysts have capillary hæmangeiomas in their walls. These angeiomas are always embedded in the cortex of the cerebellum, and frequently lie in a small dimple in the wall of the cyst.

2. Angeiomatous cysts of the cerebellum frequently co-exist with retinal angeiomas, hypernephromas, or cystic disease of the kidneys or pancreas.

3. Cerebellar cysts of this kind may have a familial incidence, occurring in members either of the same or of successive generations.

4. A close relationship to a trauma of the head or a severe fall has been established in several cases. It is probable that the trauma may start the formation of a cyst in a patient who already has an angeioma of the cerebellum.

5. Angeiomatous cysts have no lining membrane. Their walls are formed by a condensation of the normal neuroglia.

6. Simple emptying of such a cyst rarely brings about a permanent cure. Removal of the tumour from the wall of the cyst seems, however, to prevent the recurrence of symptoms.

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SPECIAL ARTICLES
ON SURGICAL TECHNIQUE.

SURGICAL TECHNIQUE OF PULMONARY ABSCESS.

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ABSCESS in the lung arises from a localized infection which may result from : (1) a preceding attack of either lobar pneumonia or bronchopneumonia, (2) an infected embolus, or (3) inhalation of infected material. The last two causes are more common precursors than pneumonia, and in the large majority of cases the pulmonary infection has succeeded some general operation or one upon some portion of the respiratory tract. Experimentally, it has been possible with certain precautions to produce abscesses of both embolic and inhalation types. Multiple foci resulting from these causes eventuate in a condition of diffuse septic pneumonia, and when the infection is localized but of great virulence, or the individual resistance low, the condition of gangrene supervenes.

Those abscesses arising as a result of pneumonia or of embolus are very similar in character, both as regards their clinical manifestations and the radiographic appearances. When they are single, and the patient has not been too exhausted by the previous illness, the prognosis with regard to eventual cure is reasonably good if they are adequately treated at the right time. Those in which inhalation of septic material has been the primary cause, on the other hand, rarely recover as completely as the former class. It would appear that this is due to delayed diagnosis, the condition being confused with bronchiectasis, purulent bronchitis, and sometimes called unresolved pneumonia. With more modern methods of diagnosis and the more general adoption of X-ray examination in doubtful chest diseases these diagnostic errors should become less frequent.

This is not the occasion to discuss the general signs and symptoms of pulmonary abscess, but in order to carry out the surgical treatment efficiently it is essential that very careful localization of the abscess should be ensured before operation. X-ray examination of the chest in these circumstances is essential. Skiagrams should be taken in the antero-posterior, lateral, and oblique positions, and in certain cases stereoscopic views may afford useful information. Abscesses following the lodgement of an embolus and pneumonia are generally similar in their radiographic appearance. In the early stages and before leakage into a bronchus has occurred, the abscess appears as a

somewhat diffuse homogeneous shadow in the clear lung area, generally inclined to be roughly circular or oval in outline (*Fig.* 77). Following rupture into a bronchus it is common to see a definite line of fluid level with a clearer area of air above, which fluid level changes with alteration in the position of the patient. This type might be termed 'the simple chronic abscess' (*Fig.* 78). In abscess following inhalation of infected material, the area of shadow is commonly more extensive and diffuse. Leakage into the bronchus occurs early, but it is uncommon to see any fluid level or to be able to distinguish the presence of air in the abscess by radiographic methods. This variety is termed 'the bronchiectatic abscess', and arises primarily in the bronchioles.
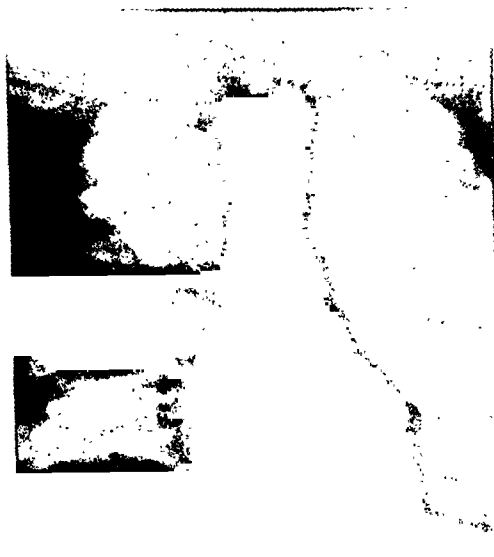
FIG. 77.—Simple chronic abscess of lung before rupture into bronchus.

FIG. 78.—Same case as *Fig.* 77 after rupture into bronchus. Note fluid level with air in upper part.

Further confirmation can be obtained by the introduction of lipiodol into the bronchial tree. In the simple chronic abscess the thick oily solution is unable to enter the abscess cavity owing to the congestion and œdema of the mucosa of the communicating bronchus. A similar condition is often present in one of the larger bronchi in cases of bronchiectatic abscess, and the sudden arrest of the lipiodol in one of the secondary bronchi can be clearly seen. Spreading out in a more or less triangular area, from the blocked bronchus as an apex, is the shadow of the abscess, this area being completely devoid of lipiodol—the 'silent area' (*Figs.* 79, 80). In bronchiectasis the dilatation of the tubes is clearly shown.

TREATMENT.

A certain proportion of abscesses in the lung clear up entirely without operative treatment. Under these circumstances all patients should be given the benefit of measures which will induce drainage through normal channels —the bronchi. All possible infective foci in the upper air-passages—teeth,

sinuses, tonsils—should be carefully examined, and if any source of infection is found measures for its elimination should be instituted. Natural drainage is encouraged by placing the patient in such a position as will most easily empty the abscess cavity into the main bronchial tubes—postural drainage. This position will vary with the site of the abscess, and to a certain extent in different individuals. When the optimum position is found it should be occupied for gradually increasing periods at least twice a day. The constant presence of spirochætes in the pus from almost all types of pulmonary abscess suggests the administration of one or other of the arsenical preparations. Intravenous administration of novarsenobenzol, in small doses at intervals of five to seven days, is of advantage. Should the abscess show definite signs of healing both from the clinical and—more important — from the radiographic examination, operative interference should be withheld; but if in spite of the above measures there is no improvement, or even deterioration, surgical drainage should be instituted.

Pre-operative Treatment.— No effort should be spared in getting the patient into as fit a state as possible before operation, and in certain cases this will require such measures as transfusion of blood; rectal administration of fluids with glucose, cardiac stimulants, and the judicious use of hypnotics for the induction of

Fig. 79. — Bronchiectatic abscess (inhalation). Unfilled area between two normally filled areas. Small blocked bronchus shown by arrow.

sleep for a day or two before operation are all of value. On the day of operation every effort is made to induce the patient to evacuate, by posture, the fluid contents of the abscess cavity.

Anæsthesia.—Local anæsthesia is the method of choice in these cases. It may be preceded by an injection of morphia, $\frac{1}{6}$ gr., atropine $\frac{1}{150}$ gr., hyoscine $\frac{1}{150}$ gr., injected half an hour before operation. Paravertebral anæsthesia is quite unnecessary, and local infiltration with anæsthetization of the intercostal nerves involved is invariably sufficient.

When general anæsthesia is used some form of positive-pressure administration should be adopted, and gas and oxygen is the anæsthetic of choice. By inducing positive pressure, when the abscess is opened aspiration into and flooding of the bronchial tree by the purulent contents is prevented.

Operation.—Abscesses arising in the upper lobes are best approached through an upper axillary incision, of the middle right lobe through an anterior incision, and of the lower lobes through posterior incisions, the exact position depending upon the site of the abscess. That point on the chest wall nearest to the abscess is chosen in order as far as possible to avoid interference with and damage to normal lung during the operation.

OPERATION IN ONE STAGE.—A vertical incision of from three to four inches in length is made through the superficial tissues of the chest wall, exposing the ribs and intercostal structures. A rib overlying the abscess is resected subperiosteally, and the subjacent periosteum and pleura are examined. The presence of œdema and a sensation of firmness is good evidence of adhesions between the pleural layers. An aspirating needle is now inserted into the subjacent adherent lung and an attempt made to enter the abscess. The presence of the point of the needle within the abscess cavity is shown by the aspiration of pus or of foul-smelling gas.

When the abscess is somewhat deep-seated it is advisable to leave the needle *in situ* and to incise the lung alongside the needle until the abscess cavity is exposed. The small track may be enlarged with forceps to allow adequate exposure, but it is better practice to use a cautery at a dull red heat, as vessels with their walls held wide open by the rigid inflamed tissue will be sealed by the cautery and embolism thereby avoided. The contents of the abscess, pus or inspissated mucopus, are carefully removed. Hæmorrhage from the walls of the cavity is rarely serious and can be controlled by light packing with dry gauze for a short while, or with gauze which has been soaked in coagulen and squeezed almost dry. Care should be taken not to allow the gauze to enter the bronchus, as it will result in excessive coughing attacks.

Drainage should be carried out by means of a soft-walled drainage tube, but it is necessary, when there is a considerable area of induration around a large abscess, to remove a portion of the rib above or below (whichever is

FIG. 80.—Same case as *Fig.* 79, lateral view. Note 'silent area' with small blocked bronchus near hilum, indicated by arrow.

better in the individual case) with the intercostal structures between the resected ribs, to permit retraction of the pulmonary tissue as healing occurs. In the majority of cases close suture of the chest wall around the tube is to be avoided, and, to prevent a spreading cellulitis, the wound should be left open and lightly packed with gauze.

In the bronchiectatic abscess the bronchial fistulæ show themselves by respiratory sounds at the time of operation, but in the simple chronic abscess communication between the bronchus and the abscess cavity will not be free for two or three days—i.e., until the œdema of the mucosa has disappeared.

OPERATION IN TWO STAGES.—Where, after resection of a rib, adhesions between the pleural layers are absent—in some cases the lung can be seen moving freely beneath the parietal layer—it is inadvisable to open the abscess in one stage. A portion of the adjacent rib is resected and the intercostal structures between the resected ribs are separated from the parietal pleura and removed. Careful palpation of the subjacent lung through the intact parietal pleura may disclose evidence of induration. Should this be the case, a pack of iodoform gauze is laid against the parietal pleura and the superficial parts of the wound are loosely closed over it. Firm pleural adhesions should be present in six or eight days as a result of the irritation caused by the pack.
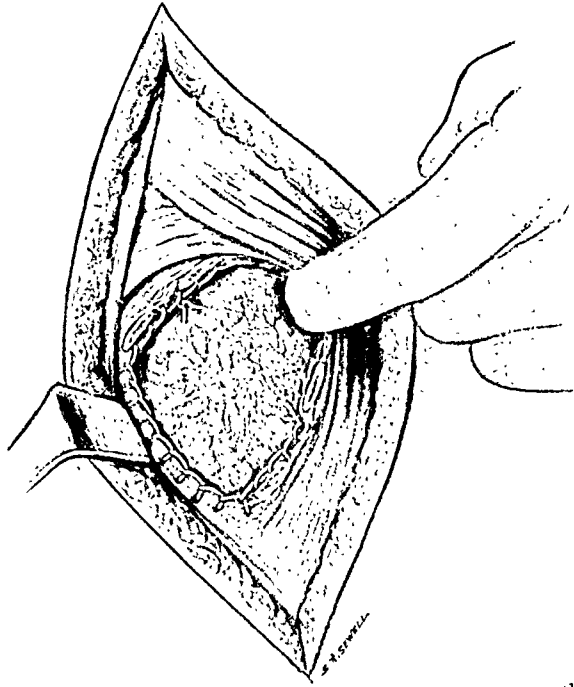

FIG. 81.—*Stage I of two-stage operation. In this case the pleura has been opened and the indurated area brought to the surface and sutured.* (Inhalation abscess.)

When no induration can be felt in the lung a small incision is made in the parietal pleura and the finger inserted to palpate the lung. If air is allowed to enter the pleural space slowly there is no shock in this procedure. The indurated portion of the lung is brought up to the opening in the pleura, and by means of an overlapping suture is fixed to the chest wall. This suture should pass through firm tissue—including the periosteum of the resected ribs and the intercostal muscles—around the edges of the wound (*Fig.* 81), not through the parietal pleura alone, which is likely to tear. The whole wound is again lightly packed with iodoform gauze for

several days to allow firm adhesions to form, and the skin is drawn together with a few sutures.

Where previous localization of the abscess has been inexact it may not be possible to bring up the involved area to the operation wound owing to the presence of pleural adhesions overlying the abscess, in which case another incision and rib resection will be required over the adherent area, the original wound being carefully sutured without drainage.

The second-stage opening of the abscess is performed in six to eight days, without anæsthetic of any sort except perhaps the administration of a small dose of morphia. After the removal of the gauze pack the abscess is sought by an aspirating needle, and the cavity opened by a cautery (*Fig.* 82). Drainage is instituted as described above in the one-stage operation.

After-treatment.—Immediately after operation the patient is returned to bed and placed in a semi-erect position, inclined towards the affected side. Expectoration is aided during coughing by firm manual support over the operative area.

The wound will require frequent change of dressing, and fœtor due to anaerobic infection may be diminished by the passage of oxygen in a slow stream through a fine catheter, introduced either through or at the side of the drainage tube. In order to eradicate the spirochætal infection almost invariably present, arsenic may be administered either into a vein or into the muscles as soon as the immediate post-operation reaction has passed off.

FIG. 82.—*Stage II* of two-stage operation. Firm adhesions are present. The original suture can still be seen. Abscess opened, after aspiration, with cautery. The openings of the bronchi can be seen in the floor of the abscess. (Inhalation abscess.)

In a well-drained case the sputum steadily diminishes in quantity and becomes less purulent and more mucoid in type, the appearance of the wound and its discharge improving at the same time. Drainage should be maintained until the sputum is negligible in quantity. the abscess cavity obliterated except for the drainage track, and the discharge almost completely serous. In the embolic and post-pneumonic abscesses complete healing may occur in six to eight weeks, but in the abscesses following inhalation healing may be delayed for several months. This is especially the case when diagnosis is delayed, treatment has been instituted at a late stage, and secondary bronchiectasis is already established.

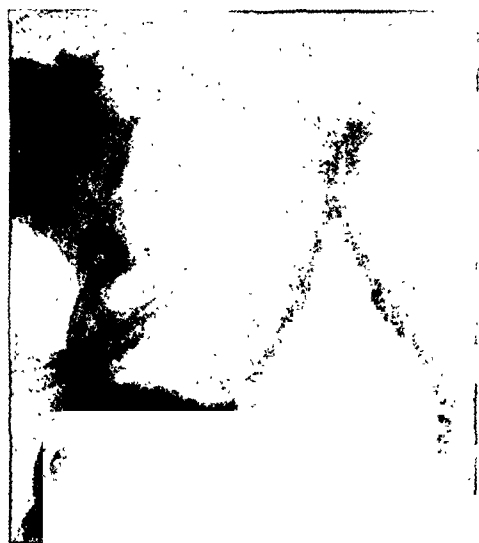**Prevention of Secondary Bronchiectasis.**—Abscesses in the lung heal in a precisely similar manner to those elsewhere in the body by the approximation of their walls and their final coalescence. In soft parts elsewhere the destruction of tissue due to infection is balanced by the elasticity of the surrounding tissues, which allows fibrosis to obliterate the cavity by contraction. Conditions in the chest, however, are altered by the comparative rigidity of the chest wall. Larger abscesses in the lung will, following drainage, slowly contract, the surrounding structures—such as chest wall, diaphragm, and mediastinum—giving way to some degree. In a number of cases, and especially in older subjects, this retraction is insufficient to obliterate the cavity. The thin-walled bronchi now commence to be pulled upon by the contracting fibrous tissue around the abscess. Distortion and dilatation of the bronchi result, and are soon succeeded by secondary infection, when the complete picture of bronchiectasis is established.

FIG. 83.—Same case as *Fig.* 77 after drainage, before lipiodol injection.

This process may delay healing of the external wound, or may follow external healing of an incompletely drained abscess. In the former case purulent expectoration and discharge from the wound will persist in spite of adequate drainage; in the latter, expectoration—which had once disappeared — will reappear, become more purulent, and increase. In both cases an attempt should be made to diminish the capacity of the hemithorax and thereby produce relaxation of the lung. Operative measures are preceded by lipiodol injection and X-ray examination to demonstrate the bronchial dilatation (*Figs.* 83, 84).

In early cases of secondary bronchiectasis, and especially those in which the healing of the external fistula is followed by increase in sputum, phrenic avulsion is often curative, and in all cases should be given a trial before more serious measures are contemplated.

FIG. 84.—Same case as *Fig.* 83 after lipiodol, showing localized bronchiectasis resulting from contraction of abscess. Permanent healing without symptoms followed phrenic avulsion.

In those in which bronchiectasis is established before the abscess has been opened, phrenic avulsion will need to be followed by prolonged drainage.

Fig. 85.—Generalized bronchiectasis secondary to drainage and external healing of large pulmonary abscess. Condition one year later required complete thoracoplasty.

When bronchiectasis secondary to a healed abscess has become well established and generalized, complete thoracoplasty preceded by phrenic avulsion will be necessary (*Fig.* 85).

DUODENAL ULCERS FOLLOWING BURNS: WITH THE REPORT OF TWO CASES.

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CURLING in 1842 first described a duodenal ulcer following a burn, and Sherren in commenting on this in Choyce's *System of Surgery* says, " Ulcers occurring in the duodenum complicating severe burns were described by Curling in 1842 (Fig. 380), and it is said they may also be present in the stomach, and in the intestine lower down. Usually single, they are met with most often in the first portion and begin as hæmorrhagic erosions. They are said to occur, as a rule, from seven to fourteen days after the burn, but they may be discovered earlier—in one case (Parfick) they were seen within eighteen hours. These ulcers often lead to a fatal issue within a few days, from hæmorrhage or perforation. They were most frequently met with by older writers. Thus Fenwick, from the statistics of Holmes, Erichsen, Perry and Shaw, found this complication in 6·2 per cent of all fatal cases of burns. These ulcers are now not often found after burns, and *some authors deny that the two conditions are associated*. Various explanations have been given of the development of the acute ulcers, but they are probably of toxæmic origin, and can thus be brought into line with other acute peptic ulcers."

Similar views seem to be held by most text-book writers, and the position is that the majority of authors are agreed that duodenal ulcers do occur after burns ; but one gains the impression that very few present-day surgeons or pathologists have actually seen such ulcers, and there appears to be some divergence of opinion as to the exact portion of the duodenum in which they occur, whether they occur in children or in adults, and whether they are likely to perforate or not.

It would be excusable, therefore, if after many years of a type of practice in which one would expect to meet such cases and did not meet them, one began to doubt whether duodenal ulcers really did occur to-day after burns, and thought that possibly the mere assertion that they did so was one of those statements which have been taken over from one text-book to another without actual verification by the different authors. I say " really did occur to-day " because there would appear to be some justification for thinking that such ulcers did occur more frequently in, say, Curling's time than to-day, for three reasons : (1) Because oil lamps, candles, and gas lamps have to a large extent been superseded by electric light ; (2) Because of the more cleanly treatment of burns ; and (3) Because of the decrease of drunkenness in later years, especially in the British Isles since the War. (Children of the working classes are possibly better protected by their parents.) The experience of my predecessor as District Surgeon in the Central Area of Johannesburg

(Dr. Heberden), who definitely informed me that, although during the ten years he held the post he had always particularly looked for duodenal ulcers when performing post-mortem examinations in cases of burning and scalding, he could not recollect ever having seen one; the experience of the other two District Surgeons in Johannesburg (Dr. W. Girdwood and Dr. R. Ray), one of whom has held office for over fifteen years and the other for nearly ten years, without having seen such an ulcer after a burn; and my own experience until recently rather tended to support the doubt. I have held the post of District Surgeon for thirteen and a half years and have rarely failed in cases of burning and scalding to look for duodenal ulcers, and until recently I have never seen one. The post-mortem examinations are carried out in the Government Mortuary, where at any rate during the last thirteen and a half years we have averaged between 900 and 1000 examinations per annum. All persons dying from unnatural causes and all deaths from accidents (including all burning and scalding accidents) in the Johannesburg magisterial area (approximately 100 square miles) and for some distance beyond, must come to this mortuary. Our experience, therefore, is not inconsiderable, yet in spite of this mass of suitable material neither my predecessor nor my colleagues in this type of work nor I (until recently) had seen a case.

Now, however, my doubts have been set at rest. A couple of years ago I found a small ulcer in the duodenum of a child who had died from the effects of burns. I have lost the specimen, and my recollection of the case is not very accurate in details, but there is no doubt about three facts in connection with the case: (1) The victim was a child; (2) Death was due to burns; (3) There was a duodenal ulcer. In addition to this case I may say that on one or two occasions I have seen a duodenitis after burns or scalds.

On Aug. 1, 1928, I examined the dead body of a native female child, age 3 years and 11 months, who had died on July 31, as a result of scalds. The child had been accidently scalded on July 21 and was admitted to the Non-European Branch of the General Hospital, Johannesburg, on that day. The hospital notes say that she was suffering markedly from shock on admission. She recovered from the shock, however, in about thirty-six hours, and then the stage of reaction followed by that of toxæmia set in as evidenced by the temperature chart. The temperature varied between 99° and 102° for the following eight days, the pulse from 116 to 140, and respiration from 22 to 44. The child died on the tenth day after admission.

At the post-mortem examination I found that there had been extensive scalds on the front of the neck, left side of the neck, and behind the left ear. There was also extensive scalding of the left arm, the front and left side of the chest and abdomen, left scapular region, left lower limb, left buttock, and right arm. The scalds were septic. The right lung was adherent to the diaphragm by recent adhesions. There were small patches of lymph on the surface of the right lung, and there was evidence of bronchopneumonia in the lung.

On the anterior surface of the first part of the duodenum I found a perforated ulcer (Fig. 86) which I demonstrated to half a dozen members of my class of Forensic Medicine who were in the mortuary. Then, before disturbing the parts, I sent for Dr. J. Harvey Pirie, late Senior Pathologist to, and

at present engaged in research work at, the South African Institute for Medical Research, to verify my 'find'. I removed the duodenum and stomach and had the specimen preserved and photographed at the South African Institute for Medical Research, where it has also been seen by three
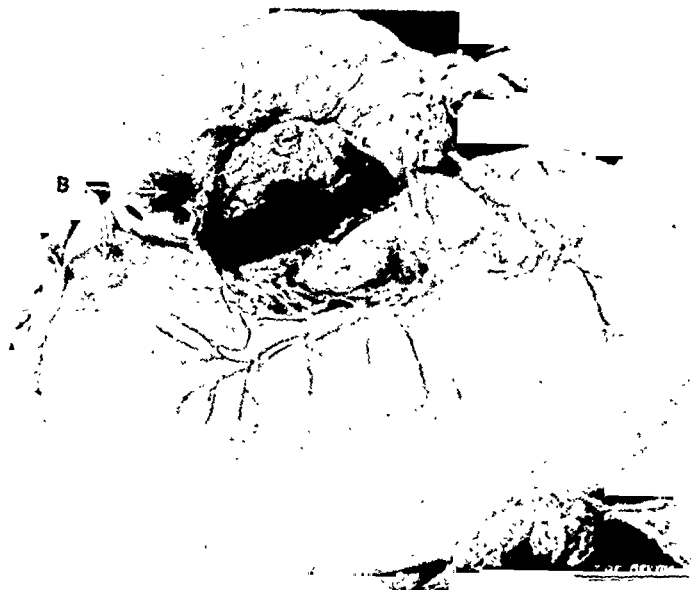

Fig. 86.—Showing perforated ulcer on the anterior surface of the first part of the duodenum.   B, Bile staining.

other experienced pathologists. There was no evidence of peritonitis or escape of stomach or intestinal contents. One therefore concluded that the ulcer had perforated shortly before death and the bronchopneumonia following the burns was the cause of death.

PATHOLOGY.

Pathologists are apparently not yet agreed about the exact pathology of duodenal ulcers associated with burns. Some think that they are due to vascular thrombosis, others that they are due to the elimination of toxins from the liver by way of the bile-duct, the toxins being absorbed from the septic burnt or scalded areas. It seems to me, however, that if one accepts as a theory for shock the following sequence of events—trauma resulting in lowered blood-pressure followed by interference with tissue metabolism ending ultimately in an acidosis—a more or less satisfactory pathology for duodenal ulcer associated with burns can be evolved which fits in with the usually accepted theory for the causation of duodenal ulcers generally.

In severe burns four stages develop as a rule : (1) The stage of profound shock (more profound in children) ; (2) The stage of reaction ; (3) The stage of toxæmia ; (4) The stage of recovery or death.

As a result of the shock if there is not a *true* hyperacidity one can safely

assume that the alkaline reserve has been seriously depleted and that there exists at any rate a *relative* hyperacidity. Toxins are absorbed into the tissues in cases of burns, first as a result of the production of a peculiar substance, said to be akin to histamine, and secondly as a result of the sepsis in the burnt areas. We have therefore the toxins which devitalize the duodenal mucous membrane causing possibly an erosion, and also the hyperacidity which favours the full development of an ulcer.

The localization is explained, as all duodenal ulcers are explained to-day, by the tortuosity of the vessels of the lesser curvature of the stomach and first part of the duodenum and their relatively poor anastomosis rendering them more liable to thrombosis.

The whole present-day theory of the development of gastric and duodenal ulcers is, to my mind, unsatisfactory, but I suggest that by bearing in mind the ultimate acidosis of shock a theory for the development of duodenal ulcers associated with burns, *especially in children*, can be conveniently fitted in.

CONCLUSIONS.

1. Acute duodenal ulcers are found post mortem in cases of death following burns and scalds, but rarely so.

2. There would seem to be special reasons for their occurring in the first part of the duodenum.

3. These ulcers may perforate.

4. The ulcers do occur in children (Curling's case and the two cases here recorded), and are possibly more likely to do so because of the more profound shock in the young.

THE TREATMENT OF CONGENITAL DEFECTS OF THE BLADDER AND URETHRA BY IMPLANTATION OF THE URETERS INTO THE BOWEL: WITH A RECORD OF 17 PERSONAL CASES.

(Based on a Hunterian Lecture delivered at the Royal College of Surgeons of England, on Feb. 8, 1928.)

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INTRODUCTION.

An early interest in the incontinent bladder has perhaps been the means of attracting these cases to my care, and I hope that a review of the results will stimulate further interest in the treatment of these distressing deformities, and will justify the method which has been employed.

As a dresser in the wards of the old Royal Infirmary at Newcastle-upon-Tyne in the year 1896 and afterwards, I saw much of two cases of ectopia that were being treated painstakingly and laboriously by the plastic measures then in vogue, and I remember vividly the utter futility of the conscientious efforts of that most careful and painstaking surgeon, the late Dr. G. H. Hume. The distress of another patient (Fig. 87), whose ardent nature impelled him to seek that sexual gratification which his disability denied him, also made a profound impression on my mind, and I have never lost sight of the importance of the sexual problem in these cases. At that time most surgeons were discontented with these plastic operations, for, at the best, they could only make it possible for the patient to drag out a less miserable existence with the aid of some form of apparatus to catch the urine.

In these cases I think the fortitude of the patients was even more to be admired than the perseverance of the surgeons. One patient, a young man of 20, who subsequently came under my own observation, submitted to nine plastic operations in two years, the final result being depicted in the photograph (Fig. 88 b), which shows that the maximum result obtained was the protection of the upper part of the exposed bladder by a flap of skin, and that he still has to wear a large and cumbersome apparatus. At night the latter is useless and he lies in a pool of urine. As may well be understood, this patient is a determined Northumbrian, for, at 15 years of age, before any operation was contemplated, he started to work in the pits, and it was only the non-success of the urinal which he then wore that induced him to seek surgical aid. Ever since the last operation he has continued at work, and now at 41 years of age he is regularly employed. He is in good health, and without any evidence of infection or of renal insufficiency. But this case is nothing compared with that of a boy recorded

by Stewart McKay,[1] who between the ages of 4 and 10 endured no fewer than forty-nine such operations until he was finally relieved by the transplantation of the ureters into the bowel.

In those early days I also saw attempts made to establish a permanent opening between the bladder and the rectum, the idea being that the route into the rectum having become stabilized, the sphincter ani would control the escape of urine and the bladder could be completely closed at a later date. Alas! all these methods were unavailing, and both surgeons and patients became inured to disappointment. Further, I was brought up in the belief that the union of the ureters to the bowel was always followed by ascending infection of the kidneys which soon proved fatal, and that position was generally accepted amongst surgeons, and I fear has not quite disappeared even to-day.

In 1911 new interest was aroused in this subject as the result of a paper by Sir Harold Stiles,[2] which he read before the American Surgical Association in Denver City, on "Epispadias in the Female and its Surgical Treatment, with a report of Two Cases". He there described a method which he had devised of implanting the ureters into the sigmoid which aimed at making a valvular opening, by which he hoped to lessen the

FIG. 87.—The parts from an adult, the subject of complete ectopia vesicæ. Note the dilatation of the ureters and the well-developed testicles; also the wide separation of the pubes, and the very thick and strong interpubic ligament.

risk of ascending infection. The cases were both female children, on whom he had operated by this method with good results. Personally I was prepared for the announcement, for in March of the previous year in Edinburgh I had seen the first patient on whom he had carried out his operation. She was then in good health and with perfect rectal function and control. (See p. 176 for further history of these patients—Cases C. D. and A. McK.)

I was at once arrested by his work, for I conceived that at last there was some hope of relieving the miserable condition of this class of case. Soon after the publication of his paper Sir Harold told me of a visit which these children had made to the theatre, and I was fascinated by the story of these little girls who were able to sit in comfort and enjoyment throughout the whole performance of *Peter Pan*.

Such is the story of my personal introduction to the treatment of these cases by transplantation of the ureters. But the whole history extends over many years—since the attempt of Mr. Simon (later Sir John Simon) in 1851 to make a communication between the ureter and the bowel, and the further deliberate effort made by Sir Thomas Smith, who in 1878 did actually in two stages unite both ureters to the colon in one of these cases. But these plans were pioneer work and were not then successful, and the very numerous methods which have been devised and

FIG. 88.—(*a*) A man, *41 years of age*, with a persistent *ectopia, who works regularly* about the mines. (*b*) Twenty years ago, as the result of *nine* operations, the upper part of the exposed bladder was covered by a flap of skin. This enabled him to wear the cumbersome urinal on which he still depends for keeping him reasonably dry during the day. At night he is continuously wet.

tried during the intervening years unfold a wonderful chapter of persevering ingenuity on the part of innumerable surgeons the world over, and great fortitude on the part of countless sufferers. The mere recital of the names of those who are known to have taken part in the work would make a formidable list, and would not by any means indicate the amount of effort expended, for nameless numbers have contributed their quota and masses of animal experimentation have also been carried out.

Briefly the method of Stiles is an intraperitoneal anastomosis of the

ureters into the recto-sigmoid (*Fig.* 89). The operation is carried out through an abdominal incision. About 1½ inches of the ureter are buried in the bowel wall, much after the fashion of the Witzel gastrostomy. The ureters are anastomosed one at a time, with an interval of two or three weeks or more, depending on the recovery from the first interference. Probably there is always some mild renal infection, but that which occurs after the first operation seems to confer some immunity against the severity of any which may occur after the second ureter is transplanted.

The patients soon learn to retain their urine in the rectum, and, in nearly
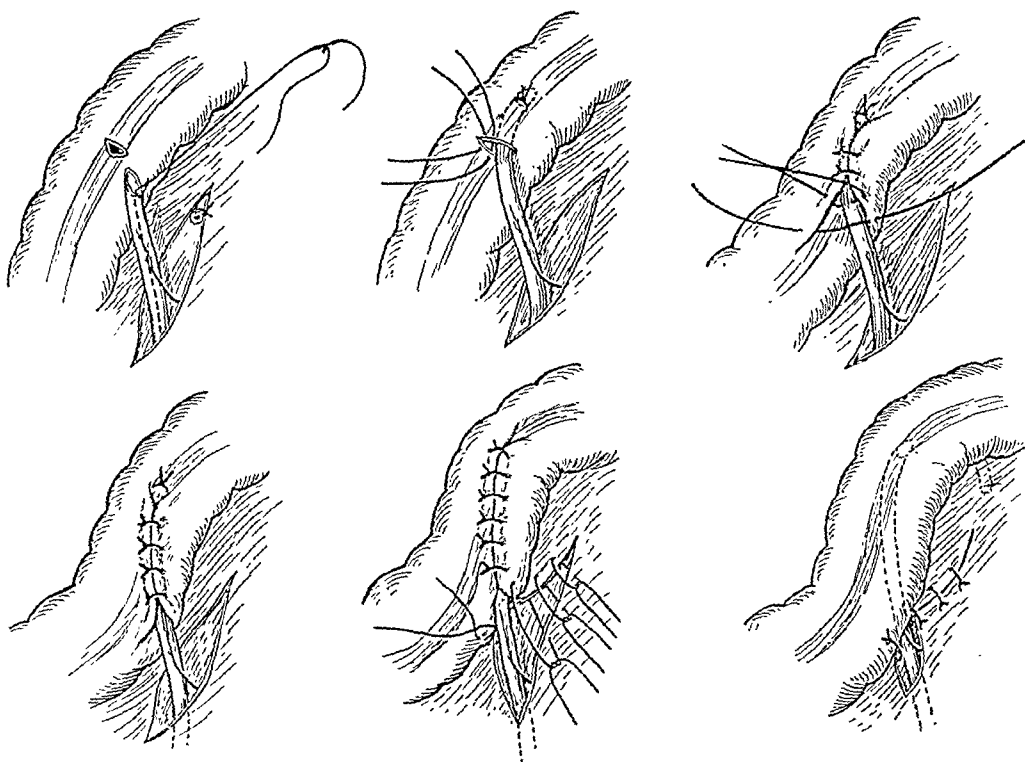
FIG. 89.—Showing implantation of the ureter by the method of Stiles. Note that the ureter is buried obliquely in the bowel wall, and not entirely in the length of the bowel as shown in the original illustrations in Sir Harold Stiles' paper.

all cases, continence becomes complete. When the renal function has become established any necessary plastic operation for the repair of the deformity is carried out.

All but two of my cases have been operated upon by this method, because I recognized that with so rare an abnormality only a few opportunities would occur to any one surgeon, and I thought it better to gain a useful experience in some one method of proved efficiency rather than to try afresh the numerous plans which have been stoutly advocated from time to time.

The congenital defects for which the operation has been carried out have been the various degrees of exstrophy of the bladder and epispadias with incontinence, in both sexes. The frequency of these conditions is difficult

to estimate. For a very long time the existence of the condition of epispadias in the female was overlooked, and, as effective treatment was not thought possible for that condition in the male when complicated by incontinence, many cases were discouraged from seeking surgical advice. Although doctors may be in extensive practice for many years without encountering a single case, the experience of all large hospitals shows that a considerable number gravitate to such centres every year. In the Mayo Clinic, up to the end of 1927, they had treated 115 cases,[3] and at an earlier date, among 367,000 patients seen at the Clinic, there were 69 suffering from exstrophy of the bladder. The latter deformity is stated to occur once in 50,000 or 30,000 births. On this basis Lower[4] states that 2,000 examples of the deformity must occur in America every year. In a paper by C. H. Mayo and William A. Hendricks,[5] the following statement occurs : "Statistics show that 50 per cent of all persons afflicted with exstrophy are dead by their tenth year, and 66·67 per cent are dead by their twentieth year." From my own personal experience I doubt very much if this is really a natural mortality, and I suspect that if it occurs it is largely the result of neglect.

I have watched seven of my patients survive from their earliest infancy and arrive at a stage at which operative measures could be hopefully contemplated. The mere presence of the deformity in no way interfered with their development, and, except for the annoyance of the incontinence, their upbringing has not been especially difficult, though some of them have been subject to crying fits which have been embarrassing because difficult to explain. No special local treatment has been carried out except that the parts have been kept constantly covered with a greasy cloth to protect the delicate mucous membrane of the exposed bladder from irritation by the napkin. For this purpose vaseline has been found best. The children are bathed and otherwise attended to in the ordinary way. Whenever possible the mothers have been seen at an early stage and have been encouraged to give the same devoted attention to these children as they would to their normal offspring. Only in one case, a baby of less than twelve months, did I observe signs of neglect, and in that particular instance, if the child had been left in charge of the parents, I think it is highly likely that it would have succumbed from this cause. It was thin and ill-nourished and suffered from prolapse of the rectum, made worse by fits of prolonged crying. Dr. Dunlop Lickley very kindly admitted the child under his care to the Children's Hospital, and with ordinary attention the baby progressed normally and had no recurrence of the prolapse. Six months later the anal sphincter was perfectly competent, and there was no evidence of unusual laxity of the lower bowel (*Case* 14).

In addition to the 17 cases here recorded, I have seen several others who have attained maturity, and in only one, an example of epispadias in the female, in which the patient had reached the age of 26 years, was there any definite evidence of renal infection, and that patient subsequently died at 31 from that cause, no operative interference having been attempted.

The principal facts connected with my own series of cases are set out in the following table, and the full details will be found in the notes of the cases which follow.

TRANSPLANTATION OF URETERS FOR CONGENITAL DEFECTS :
CASES AND RESULTS TO END OF 1927.

NO.	INITIALS, SEX	AGE AT OPER-ATION	DATE OF OPERATION	STAGES	RESULT	YEARS SINCE OPERA-TION	PRESENT CON-DITION	REMARKS
1	F.B., m.	8	Dec., 1912	Two	Cure	15	Quite well	
2	E.T., f.	22	Dec., 1914	Two	Cure	13	Quite well	Married since operation ; 2 children
3	W.K., m.	19	March, 1917	Two	Cure	$10\frac{10}{12}$	Quite well	Slight incontinence at night only
4	E.L., f.	20	May, 1917	One	Died			Peritonitis
5	V.K., f.	6	Nov., 1917	Two	Cure	$10\frac{2}{12}$	Quite well	
6	J.T., m.	13	May, 1919	Two	Died			Peritonitis
7	W.P., m.	5	May, 1920	Two	Cure	$7\frac{7}{12}$	Quite well	
8	N.B., m.	13	Jan., 1921	One ureter only	Cure	$6\frac{11}{12}$	Quite well	
9	T.L., m.	4	Nov., 1921	One	Cure	6		Urinary fistula after plastic on bladder
10	J.F., m.	$10\frac{1}{2}$	March, 1922	Two	Cure			Well for 3 years and 3 months, then died from intestinal obstruction
11	E.H., f.	$2\frac{2}{12}$	March, 1923	One ureter only	Died			Peritonitis
12	J.P., m.	10	Oct., 1924	Two	Cure	$3\frac{2}{12}$	Quite well	
13	W.B., m.	4	Sept., 1925	Two	Cure			Well for 2 years and 3 months, then died after plastic on bladder
14	J.M., f.	$1\frac{4}{12}$	May, 1926	One ureter only	Died			Septic dermatitis
15	T.L., m.	$8\frac{3}{12}$	June, 1926	One ureter only	Cure	$1\frac{5}{12}$	Quite well	Urinary fistula persists (see Case 9)
16	J.H., m.	3	Oct., 1927	Two	Cure	Recent	Quite well	Kidney decapsulated. Not yet acquired complete rectal continence
17	G.M., f.	$3\frac{6}{12}$	Dec., 1927	One ureter only	Cure	Recent	Quite well	Not yet acquired complete rectal continence

NOTE.—In *Case* 17 the second ureter was transplanted in May, 1928, and the patient continues in good health.

Out of the series of 17 cases there have been 4 deaths directly due to the operation. One patient died over three years and another over two

years after operation, and both had enjoyed good health during the intervening period. Of the remaining 11 patients, 1 is included twice for reasons set out in the case record. This leaves 10 patients alive and well at periods varying from fifteen years to seven months since operation.

DETAILED NOTES OF 17 CASES.

In every case the operation was carried out for the relief of incontinence of urine. The age stated is at the time of the first operation.

Case 1.—Total epispadias. Transplantation of both ureters in two stages at seven months interval. Recovery.

F. B., male, 8 years at time of operation. (Reg. Nos. 5249 and 5250.)

HISTORY.—This patient was a rather delicate and under-sized weedy-looking boy, the fifth child among seven born of not very robust parents. Unfortunately no record was kept of his weight or height. He came under observation when 8 years of age, having suffered from incontinence of urine from birth, the result of total epispadias with separation of the symphysis pubes.

FIRST OPERATION, May, 1912.—The right ureter was implanted into the sigmoid, after the method described by Mr. (now Sir) Harold Stiles[2] (*see Fig.* 89). The boy stood the operation quite well, but developed a severe attack of whooping-cough during convalescence, and it was not until seven months later that it was judged the second ureter could be safely transplanted. He had not quite got rid of his cough, and when re-admitted to hospital he was found to be rather thin and white.

SECOND OPERATION, Dec. 6, 1912.—Anæsthesia by open ether. The Trendelenburg posture was used, and the middle line incision re-opened. A little clear fluid was present in the peritoneal cavity. There were only a few flimsy adhesions and the pelvis was easily exposed. The pelvic colon was large and thick-walled, and the rectum was so much distended as to occupy nearly the whole pelvis. The right ureter could be plainly seen lying on the rectal wall and running into it. It was not obscured by adhesions and was securely healed. It was dilated to about twice the normal size, but when vermiculating it appeared to return to its usual size. Many small glands were seen along the line of this ureter as it lay on the rectal wall.

The left ureter, which was normal in size, was implanted into the bowel, a little higher up than its fellow, but by exactly the same technique which had been employed on the right side. The anastomosis made on the left side was a little less oblique than that on the right. At the end of the operation the ureter was noticed to pass from the pelvic wall at more or less of a right angle, and the part above was already a little dilated, suggesting some slight obstruction. In the hope of arresting sexual development half an inch of both vasa were excised in the pelvis and the ends were allowed to retract. The operation occupied about an hour.

PROGRESS.—Immediately after the operation the boy was extremely shocked; he had difficulty in breathing and became very blue. The pulse was irregular and soft. After oxygen and saline infusion the condition improved. The patient had a restless night, but looked much better next day, though the respirations were very rapid. However, he steadily improved, and a fortnight after operation was very well indeed and the wound was quite sound. He required to use the bed-pan six or eight times a day and about twice at night; very seldom had wet beds and then not much. On the sixteenth day he was allowed to return home, where he rapidly acquired good rectal control. His mother made a practice of getting him up to empty the rectum just before she retired for the night and again first thing in the morning. During the day he had no trouble whatever, and went to school and took part in the usual games and mischievous pranks beloved of boys of his own age.

April, 1917 (four years and four months after the completed operation): The boy had kept very well until the previous winter, since when he had suffered from cramp in the stomach, pain in the loins, and weakness of the legs. He looked thin and ill-developed and was too small for his age. The pulse was weak and of poor tension, but he took his food very well. The bowel had to be emptied after every meal and about twice each night. Control was usually good, but there was sometimes a slight accident if he was not able to relieve himself immediately. The evacuation was like dirty water and smelt badly.

In April, 1918, he was just over 14 years of age, and weighed 4 st. 3 lb. 2 oz. By this time his general health was much better and he looked well and was able to run about all

day and sometimes played football. He wanted to begin work as an errand boy, but the firm required a doctor's certificate before they would allow him to start. As a rule he went to bed about 9.30, and was awakened when his parents retired at 10.30 in order that he might empty the rectum. After this he was usually not disturbed again until about 7 a.m. Sometimes he had to get up once during the night, but he never wetted the bed.

In November, 1920, just eight years after the operation, he was aged 16 but still looked small and thin for his years. He then weighed 4 st. 12 lb. 3 oz. The boy was quite well, took food well, and had never been under a doctor since the operation. The rectum was emptied not more than three or four times during the day and at 10.30 p.m., and then not again till 6.30 in the morning, which was the time he had to get up and go to work. As a rule fæces and urine were intimately mixed, but he did occasionally pass a solid evacuation. On the day that he came to the hospital to show himself, after waiting for two and a half hours, he passed 10 oz. of urine. He was then employed as a rivet catcher and earning twenty-five shillings a week. In his spare time he idled exactly as other lads of his own age, and was very fond of playing football. He occasionally suffered from cramp in the bowels and diarrhœa, and lost about two days every month from this cause. The scar of the incision was strong and there was no hernia. The testicles were of normal size and secondary sexual characteristics were developing.

During 1922 this boy kept very well, but was out of work on account of industrial depression. Towards the end of that year he looked thin and poorly, and was found to be developing knock-knee. Both femora were affected, and there was marked down-growth of the internal condyles. When admitted to hospital for the treatment of this condition he was 18 years of age. He was rather anæmic and seedy and there was evidence of generalized rickets, as shown by thickening of the epiphyses and by a marked rickety rosary. He was able to hold his water for five hours without emptying the rectum, never wet the bed, and only occasionally had to get up at night. The evacuation varied a good deal, being sometimes clear like ordinary urine, or a thick, brown mixture, or very rarely a solid stool.

In October, 1922, I operated for the genu valgum, carrying out Macewen's osteotomy on both sides (Reg. No. 14750). The operation was performed under ether anæsthesia, and the patient was kept under its influence for over an hour until the plaster was applied to both sides. Recovery was uninterrupted, and he was able to leave the hospital on the ninth day, not in any way upset by his experience. The ultimate result was very satisfactory, and under supervision and a suitable régime the rickety condition very soon improved.

a   .   b
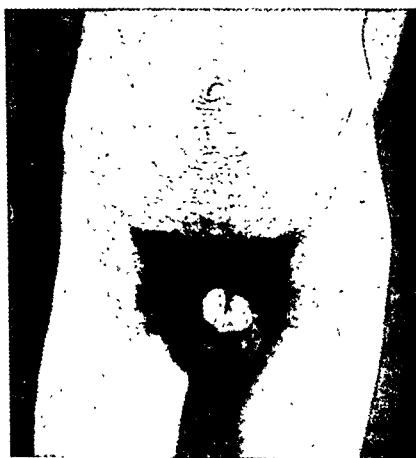
FIG. 90.—Case 1. F. B. Photographs taken 15 years after transplantation of ureters, showing: (a) General development; (b) Genital development.

In February, 1926, the boy was out of work for a short time with 'lumbago' and was attended by his family doctor. By June of the same year he again complained, and was put down as suffering from the same complaint and debility. Since then he has been attended for 'looseness of the bowels' and for influenza colds, but has had no further symptoms that could fairly be attributed to his disability. The family doctor informed me that he had only once attended him for an attack in which he suspected ascending renal infection.

In May, 1926, this patient was shown at a meeting of the Association of Physicians. He was then in ordinary good health and made no complaint of any sort. The opportunity was taken to examine the urea content of the urine and blood, with the following result: Urine urea, 0·62 per cent: blood urea, 52 mgrm. per 100 c.c. This examination, therefore, indicated some degree of renal inefficiency. On Dec. 31, 1927, his 24th birthday, he was 5 ft. 4½ in. in height, and weighed 7 st. 9 lb. His general health was quite good and he appeared normal in every respect, but still looked rather thin and not very robust (*Fig. 90 a*).

He urinates, per rectum, after breakfast, dinner, and tea, and at bedtime. Sometimes he gets up once in the night if he drinks a large quantity of water, of which he is very fond, but he never wets the bed. The evacuation is usually mixed faeces and urine, but at times he passes a normal stool, and states that he can pass wind without water. The lad smokes about fifteen cigarettes a day. The pelvis is well developed and the pubic bones look normal in the X-ray picture, but they are separated by half an inch and are not on the same level. The lower ends of the femora and upper part of the tibiae are quite normal. The penis and testicles are well developed, and there is a free growth of hair to the umbilicus (*Fig. 90 b*). Occasionally he has experienced an erection and has had nocturnal emissions.

The patient left home about 9 a.m., just after emptying the rectum. About 1 o'clock he had dinner in the hospital, and just after his meal felt as if he wanted to empty the rectum but did not do so. About 1.15 an examination with the sigmoidoscope was carried out. The anus looked normal and grasped the finger firmly. The lower rectum was empty, but when the instrument had entered to about the length of the forefinger, urine commenced to well up into the field from the bowel above, flooding the intrument. In this way about a pint came away and then the boy sat down on a chamber and passed a good deal more. The total evacuation, which was almost entirely urine, was found to measure 29 oz. The rectum and sigmoid appeared normal, and there was really nothing to remark except perhaps a rather unusual moisture of the mucous membrane. A thorough search carried out for about half an hour quite failed to locate the ureteral openings. Indigo-carmine was not used.

Summary.—Case of complete epispadias in the male with total incontinence of urine. Operation at 8 years of age. Transplantation of both ureters into rectum and sigmoid at an interval of seven months. Good recovery. Has enjoyed almost normal health since operation and has engaged in work and play like other boys of his age. In December, 1927, fifteen years after the last operation. he was 24 years old, was quite well, weighed 7 st. 9 lb., was 5 ft. 4½ in. high, and had perfect rectal function and control.

Case 2.—**Epispadias with incontinence. Transplantation of both ureters in two stages at one month interval. Recovery.**

E. T., female, 22 years at time of operation. (Reg. Nos. 7338–7339.)

HISTORY.—This patient was admitted complaining of inability to retain more than a few drops of urine. The condition had existed since birth. At 10 years of age she was admitted to a hospital and examined under chloroform, but was told that nothing could be done to remedy the disability. Between 18 and 19 years of age she was again in hospital on four separate occasions, and had as many local operations carried out. At that time when she was lying on her back she could keep dry for a short time, but as soon as the bladder began to fill it overflowed. When up she was constantly wet. At one of these operations the anterior wall of the bladder was separated from behind the pubes and split from the urethra upwards for an inch. The margins were then sutured together right down into the urethra with the object of diminishing its calibre. At the end of twelve days she went home much improved, having only wet the bed once since the operation, but the improvement was only temporary, and she was soon as incontinent as ever.

When admitted to the Newcastle Infirmary, in November, 1914, she was found to be a good-looking, healthy girl, but shy and sensitive. The underclothing was constantly wet and uncomfortable and she had always a urinous odour. The skin of the thighs was reddened and sore from the irritation. Locally the vulva showed the deformity associated

with epispadias in the female. There were scars of previous operations. The two halves of the pubes could be felt separated to the extent of about an inch.

FIRST OPERATION, Nov. 17, 1914.—Median incision below the umbilicus. The ureter on the right side was exposed and transplanted into the upper rectum by the method of Stiles.

PROGRESS.—The patient went on well until Nov. 26, when the temperature began to rise and she complained of some pain in the right side of the back. There was a trace of albumin in the urine. By the end of a fortnight the temperature and pulse had fallen, the patient was feeling much better and had no pain.

SECOND OPERATION, Dec. 18, 1914.—Just a month after the first operation the abdomen was re-opened. There was some free fluid in the pelvis. The small intestine was adherent to the sigmoid where the ureter had been implanted. These adhesions were separated and the implanted ureter was found distinctly dilated. The left ureter was now anastomosed into the sigmoid in exactly the same manner as the right, but at a slightly higher level in the bowel. The abdomen was closed in layers.

PROGRESS.—After the operation the patient's temperature and pulse were elevated and she had severe pain in her back on both sides. She became a little thin and anæmic. By the end of a fortnight urine could be retained in the rectum for two hours. The wound was perfectly healed and the patient felt much better. She was discharged with full instructions concerning the taking of urotropin, etc.

When she first returned home she lost appetite, complained of weakness and got very thin, and her own doctor said that he thought that she was going into a decline. At the end of February, 1915, she went to the South of England and stayed for some months. The change did her a great deal of good.

Just about a year after the last operation the patient reported by letter that she was very well with the exception of headaches and occasional pain in the back. Her object in writing was to ask advice re marriage. Knowing full well that contrary advice would certainly be disregarded, the patient was informed that there would be some extra risk, but that, if she was anxious to marry, she need not be deterred. She married in November, 1916, and in December reported herself as very well. She still took urotropin and thought it proved beneficial. In April, 1917, this patient asked advice about having children, and elected to take the risk. At this time she reported that the frequency of urination depended upon her general health. When feeling quite well she only emptied the bowel three times a day, and not at all during the night. On the other hand, when not feeling well, she urinated about every two hours by day and about four times each night. Rectal, or rather sphincter, control was very good, and she had only once had a little incontinence after taking some purgative pills. She often had pain across the back, and towards the end of 1917 had often to go to bed for a day or two on that account.

Each year, in December, the anniversary of the operation, she reported on her condition, and at the end of 1918 (the fourth anniversary) the report was very satisfactory. The pains in the back and the headache were often severe, but were always promptly relieved by a few tablets of urotropin. In October, 1919, nearing the fifth anniversary, the patient reported herself as pregnant. There was a good deal of backache, made worse by worry as to the approaching confinement, and as to whether the baby would be similarly affected. The confinement proved to be normal in every way. She was in labour eighteen hours and delivered herself of a healthy child on April 8, 1920. There were no complications in the puerperium, and in July the patient reported herself in better health than ever before, and she was able to nurse her child for twelve months. There was an abundance of milk.

About the time of the sixth anniversary, in December, 1920, the patient came to see me at the Infirmary with her baby. She was looking and feeling very well and able to take ordinary food, and expressed herself as better than ever before, and as delighted with the result of the operation. She supplied the following information as to her daily routine. Her work was to attend to the usual household duties and the care of her child, and also to look after a small confectioner's shop which she and her husband had started to supplement their income. In these duties she got a little help from a young maid. As previously reported, the emptying of the rectum depended a good deal on her general health, but she could go to the ' pictures ' and sit through the performance without discomfort. As a rule she was able to lie all night, but sometimes had to get up as often as four times. She did have pain and discomfort if she wanted to evacuate the rectum and had to wait to do so, but there was never any involuntary escape of rectal contents. There was still a good deal of headache and backache.

In 1921 this patient reported herself pregnant again.; she was very well except for a little bearing down, but was able to continue her work. The second baby was born without the least trouble, and the patient again made an uninterrupted recovery. During 1925 the patient had a good deal of trouble with her ' kidneys ' and was often under the doctor,

especially in the warm weather, when she seemed to be worse ; at such times she had to empty the rectum about every half hour.

On December 29, 1927, she came to report—just thirteen years after the last operation. She was then 35 years of age, measured 5 ft. 1¼ in. in height, and weighed 7 st. 2 lb. Her general health was excellent, and her children of 7½ and 5½ were thriving well. She looked fit and well, and certainly better than at any previous visit (*Fig. 91*). It was especially noticed that her teeth were well preserved. At that time she occupied a house of five rooms in a seaside resort, and ran a business in an industrial town a few miles away. She kept one maid at home and two girls in the shop. Her daily routine begins when she rises at 9 a.m. and empties the bowel before breakfast (takes ordinary food, but has a poor appetite). She then travels by train to her business, where she arrives about 11 a.m., and all day she is occupied in the shop, returning home at 10.49 p.m. Other days the hours are shorter, and one day a week she does not go to business. On Fridays she goes at 9 a.m., and does not return to her own home until Saturday at tea-time. When in normal health she empties the bowel about every three hours, and is able to hold the contents for longer if necessary. At night she gets up once at about 6 a.m., and never has an accident. When not so well, and especially in warm weather, she has to go often during the day, but never more than twice at night.

Nearly always the evacuation is a mixture of fæces and urine. She thinks she passes a lot because she drinks a lot of water. She is able to pass flatus independently of emptying the bowel.

FIG. 91.—*Case 2.* Mrs. A. W. S., age 36, with her children, born 7 years and 5 years after both ureters had been transplanted into the recto-sigmoid. She is now in good health, with perfect rectal function and control, 13 years after operation.

The headaches are not so bad as before ; her eyes have not been tested. Backache is very infrequent now, and only comes on if she gets a little cold or during menstruation. It is always on the right side and lasts not more than a day. The presence of the backache makes no difference to the evacuation.

The menstrual time is regular, but there is a good deal of pain.

On this occasion the bowel was examined by the sigmoidoscope. On request the patient emptied the rectum, voiding 2 oz. of clear urine with a large quantity of mucus. This had collected between 11 a.m. and 1 p.m., and the patient said there would have been much more if she had been drinking as usual. The skin about the anus was normal, and the sphincter was very tight, but not irritable. The mucous membrane of the rectum and sigmoid were unusually moist, but otherwise normal. The opening of one ureter was seen on a ridge : there was no vermiculation and no spurt of urine, only a steady suffusion with very clear water. This was about 8 to 10 in. from the anus. ˙˙˙ ˙˙˙ ˙˙˙ test was not used. The examination of urine resulted as follows : ˙¦ ˙ ; albumin, a trace : blood, nil ; urea, 1·5 per cent ; fair amount of mucus ; microscopically, a few pus cells and one or two red corpuscles, triple phosphate crystals, no casts. Blood-urea, 27 mgrm. per 100 c.c. X-ray examination showed that the pubes were curiously pointed and were separated to the extent of $\frac{7}{16}$ in. The pelvis was flat, the greatest breadth being 6½ in. The patient did not complain of any difficulty or weakness in walking, and the pubic bones appeared to be firmly held together by a very strong ligament.

Summary.—Case of epispadias in the female with total incontinence. Operation at 22 years of age. Transplantation of both ureters into recto-sigmoid at an interval of one month. Good recovery. Has enjoyed almost normal health since operation. Married, and has had two children born five years and seven years after operation. In December, 1927, thirteen years after operation, the patient is 36 years old and is in better health than ever before ; weighs 7 st. 2 lb., is 5 ft. 1½ in. high, and has perfect rectal function and control.

Case 3.—Ectopia vesicæ. Transplantation of both ureters in two stages at twenty-four days interval. Plastic on bladder. Prolapse of small intestine through wound causing intestinal obstruction. Recovery.

W. K., male, 19 years at time of operation. (Reg. Nos. 13708–13711.)

HISTORY.—Patient was one of a family of four brothers and two sisters, who were all healthy. Parents alive and healthy, though the father was alcoholic. The patient himself had never been to school and had only worked about the house. He took regular outdoor exercise, smoked cigarettes to excess, but did not take alcohol. Until three years ago he always lived in the country. Had suffered from measles, but had never had any other illness. Some days felt out of sorts and unfit for exertion. He was a big lad, well built and muscular, but slightly anæmic. The speech was slow and intellect ' simple '. Pulse slow and regular. Locally he presented the typical deformity of ectopia vesicæ, with wide separation of the pubes. No previous treatment had been attempted.

FIRST OPERATION, March 6, 1917.—General anæsthesia. Left ureter implanted to upper rectum by method of Stiles. The vas was exposed at its entrance into the internal ring and severed, the ends being encouraged to retract. The abdomen was closed by interrupted and through-and-through silkworm sutures. The whole operation took one hour. Anæsthetic was taken well, but the abdomen remained fairly rigid throughout. The patient had a little pain and some anæsthetic vomiting, but otherwise made a good recovery.

SECOND OPERATION, March 30, 1917.—The old wound was opened up. The site of the previous anastomosis was found to be surrounded by adhesions of small intestine. At this stage the incision was lengthened about one inch in a downward direction, and it was noticed that a thick fibrous ring was severed round the extroverted bladder. The right ureter was transplanted in a similar manner to the left, but at a lower level. Right vas divided. Abdominal wound closed by through-and-through sutures.

PROGRESS.—The day after the operation the patient had slight cough and much anæsthetic vomiting. The abdomen was tender but not distended. Next day the vomiting and cough persisted and the pulse was quick. On the following morning the patient was still vomiting and complaining of severe pain. The wound was examined and appeared to be normal. At 8.0 p.m. the vomit was noticed to be intestinal in character. The wound was again examined and about three inches of lymph-covered small-intestine and a small piece of omentum were found protruding through its lowest part.

THIRD OPERATION, April 2, 1917.—As the patient refused a general anæsthetic, spinal was employed. This was slow in acting, and he alleged that he never completely lost sensation in his abdominal wall, though he allowed the operation to be completed without interference. The protruding omentum was ligatured and excised. The lymph was removed from the wall of the gut and the latter was reduced by pressure. No attempt was made to close the parietal opening, which was packed and protected by a graduated pad of gauze. After the operation the vomiting ceased and the patient expressed himself as greatly relieved.

PROGRESS.—The next day the patient was doing well, although he still had pain and felt rather sick. From day to day afterwards he steadily improved, and by April 21 he was very well, though obviously a little anæmic. The wound was practically all healed ; there was no evidence of renal infection. He could retain urine in the rectum for two hours and sometimes over three. At night he sometimes evacuated the contents of the rectum during sleep.

By April 27 the patient having revised his opinion of general anæsthesia, another operation was performed under ether.

FOURTH OPERATION.—The bladder mucous membrane was dissected from its bed. Great difficulty was experienced in carrying out this procedure owing to excessive hæmorrhage. Numerous vessels were ligatured, but most of the bleeding took place from cavernous-like tissue existing under the lower part of the mucous membrane. The hæmorrhage having been dealt with, an attempt was made to draw together the two edges of the wound, but this was found to be impracticable owing to the tension of the abdominal wall. Finally the unclosed wound was packed with gauze. The pulse at the end of the operation was 120, and the patient was pale and collapsed from loss of blood,

but quickly recovered with the raising of the foot of the bed. After this anæsthesia he suffered very little from vomiting.

This operation was again well borne, but the next day he had frequent and sudden evacuations. From May 2 he had slight evening rise of temperature, and for a day or two complained of severe pain in the bowels on using the bed-pan. On May 9 he retained his urine for five and a half hours, and by the 19th he was well enough to be discharged to the out-patient department, the wound healing satisfactorily. Inquiries made as to sexual feelings produced a negative reply.

Early in June—that is to say, two months after the second ureter was transplanted —the urine passed per rectum was examined bacteriologically. With the smallest dilution which could be employed the colonies on nutrient media were far too numerous to count. The bacteriological fauna was indescribable, but the prevailing organism was undoubtedly *Bacillus coli.* Urotropin was given for a week, and the examination repeated, but the result was the same, there being no appreciable difference in the number of colonies.

In the beginning of September the patient came to report. He looked very well— better than before operation—and said that he was pleased it was done. He was taking food well, but complained of some pain in the right loin. He passed urine about every two and a half hours during the day and several times each night, and the bed was always wet. The bladder area was now healed except for a granulating area at the root of the penis.

Soon after leaving the infirmary he went to stay with a sister in the country and began to work on a farm, and he has followed this employment, with only occasional interruptions, ever since. In July, 1920, he stated that he habitually worked from 6.30 a.m. till 5 p.m. and often until 7 p.m. During the day he was unable to retain urine for more than one and a half hours without getting wet, and during the night he had to get up three or four times, being awakened by a slight pain in the hypogastrium. The evacuation was nearly always fæces and urine intimately mixed, but occasionally he passed a solid motion. There was no pain in the back or headache, but he suffered very much from thirst. He stated quite definitely that he had no sexual feelings whatever. He voluntarily stated that life was worth living since operation, though it was not worth while before.

In November, 1920, I had an opportunity of examining this patient. He was strong and well and had been working on the farm regularly without trouble. He was then 22 years and 10 months old and weighed 10 st. 6 lb. There was a certain degree of ventral hernia, but this caused him no inconvenience. During the day he emptied the bowel every two and a half hours. At our request he provided a sample of the contents of the rectum ; it was a mixture of urine and fæces, and measured 5½ oz., which had collected in four and a quarter hours. During the night he had to get up once or twice, and had some incontinence, but that was improving. There had been no attacks of pain in the back nor of fever. Sexual feelings were absent, but he did occasionally have an erection. From every point of view he looked on the result of the operation as a great success.

After this time the nocturnal incontinence became worse, and early in 1921 was looked upon as a great nuisance by those with whom he lodged. In March, 1922—i.e., five years after operation—he was seen and was found to be quite well, but not in very good condition, as he had been out of work owing to industrial depression, and had not been getting proper food. During the day he emptied the bowel about every two hours. At night if he slept heavily he had incontinence, but if he awakened to evacuate the bowel this was avoided. About this time he complained of scalding of the anal region, and the skin around was soddened and whitened as if subjected to constant moisture.

In August, 1923, I saw this patient in his first bad attack of renal infection. His mother informed me that up till two months previously he had been splendidly well in every way, and had very often slept all night without incontinence. During the last two months he had been losing ground, became thinner, and was much troubled with cough.

The attack for which I was consulted began on Saturday, July 28. He then felt ill and had pain in the back and vomiting. When seen by Dr. Hammond, of Gateshead, he was found to have a temperature of 104°, and later 105°, but there had been no rigor. At the time of my visit he was very flushed and had a temperature of 101°, and the mouth was dry and parched, but he was perspiring freely and said that he was much better. There was pain in the left kidney region and some acute tenderness behind, but no enlargement of the kidney could be made out. The right side was quite free. During this febrile attack he complained that the urine had escaped from the bowel involuntarily. I ascertained that he had omitted to take his potassium citrate for a considerable time. Without any special treatment he soon made a complete recovery and resumed his work in the country, which he continued without much interruption.

I did not hear from this patient again until July, 1927, when I learned that he was not well, and I went out to the country to see him. I found that he had been out of work a good deal in 1926 owing to the general industrial conditions. He lives with his sister, a married woman in humble circumstances with five children, and I have no doubt that when work is short they often do not get enough to eat. In the beginning of June, 1927, the patient began to complain of pain in the right side of the back and in the right leg, and of weakness and loss of flesh. His sister noticed that he was "hangy" and obviously not well. He felt sickly, though he never vomited. The incontinence at night was very troublesome, and happened occasionally during the day, depending on his general state. In spite of his condition he was able to do a little light work on a farm. I found him rather thin—weight 9 st. 1 lb.—but otherwise looking in fairly good condition, and I observed that his clothes were not particularly smelly. There was no sign of enlargement of either kidney, and he was not tender in the loins. The skin about the anus was again normal. It was obvious that he walked with rather a waddle, but that was always so, and its being worse probably depended on his not very good health. Under treatment with large doses of potassium citrate he quickly improved and gained weight, so that by the beginning of December, when he came to the hospital for a period of observation, he was found to be 10 st. 7 lb., a gain of 20 lb. in about four months. His height was 5 ft. 10 in., and he looked in the robust health of an ordinary countryman, and by this time his only complaint was of the nocturnal incontinence. The local deformity now consists of a total epispadias, but the penis is large and the testicles are well developed. X rays showed a well-developed pelvis with a separation of 3½ in. between the pubic bones.

FIG. 92.—*Case 3.* W. K. The appearance of the ureter as seen with the sigmoidoscope : on the left in the resting state, on the right during vermiculation and after the exhibition of indigo-carmine. The prominence of the internal iliac artery is well seen.

The daily routine he described as follows : He rises at 5 a.m. and goes to the farm, a walk of 2½ miles, to be there by 6.30. Works until 6 p.m. in summer and until dark in winter. In addition to work about the steading he goes to the fields, ploughs, drills, forks hay, etc., etc. He empties the rectum three or four times a day. At night has never acquired continence, and urine escapes involuntarily and he is quite unconscious of the leakage. In spite of this he sometimes passes some urine on first rising in the morning. He is *not* able to void flatus without leakage. The appetite is good and he is able to take any kind of food and in any quantity. The evacuations are as before, and the rectum is of good capacity, for at my request, but with an admitted effort, he retained urine from 6.30 a.m. to 10 a.m. and then passed 18 oz.

He has had a kidney attack nearly every year since the operation. During these attacks he has to remain in bed from a few days to a fortnight, and after that it takes about a week to convalesce. The attacks are now always on the right side. He has pain, fever, and frequent micturition, but never vomits. The skin of the buttocks and the anus now look almost normal, and the latter grasped the finger very well.

A sigmoidoscopic examination was made, and the rectum was emptied just before coming to the theatre. On introducing the instrument the mucous membrane was noticed to be redder than in the other cases examined about the same time. The lower rectum was empty, but on advancing the tube to just beyond the first fold

quite a quantity of urine gushed out—several ounces—as if it had been imprisoned above some valve.

The search for the ureter was not at first successful. The internal iliac artery was noticed to be pulsating very freely and vigorously. Further search revealed one ureter at about this level, i.e., 8 in. from the anus. The ureter hung into the field just like the uvula, and was recognized by the vermicular movements. It moved easily and wobbled about on introducing air with the bellows. The appearance is faithfully represented in the coloured drawing (Fig. 92). The ureter nipple was bright pink in colour, in contrast to the lighter bowel wall. It vermiculated like the normal ureter and was then drawn up a little and became a lighter pink, then relaxed and at times became bright red in colour. Urine could be seen dripping pretty freely from round about the nipple. Indigo-carmine, 4 c.c., was given by intramuscular injection, and in seven minutes the blue urine could be seen escaping in little gushes from the spot at the side of the base of the nipple, as indicated in Fig. 92. So it continued, the effluent getting all the time darker, until at twenty minutes the examination was discontinued. By that time 2 to 2½ oz. of blue urine had been collected. The other ureter could not be found. The one seen was the upper or right ureter, the patient lying on the left side. The examination of the urine collected at this time resulted as follows: Reaction, amphoteric; albumin, trace present; blood, present (pyramidon); urea, 1·50 per cent. The blood-urea from a sample sent on Dec. 15, 1927, was 34 mgrm. per 100 c.c. The lower ends of both forearm bones were examined by X rays and appeared to be normal in every way. Mr. J. S. Arkle kindly examined the fundi for me, but found no evidence of changes in the vessels.

Summary.—Case of ectopia vesicæ in the male with total incontinence, no previous operative treatment having been carried out. Operation at 19 years of age, both ureters being transplanted into the recto-sigmoid at an interval of twenty-four days. Prolapse of small intestine through the wound after the second operation caused intestinal obstruction. Replacement under spinal anæsthesia. A month after the second operation the mucous membrane of the bladder was extirpated, general anæsthesia being employed. Made a good recovery and has been greatly benefited by operation, but has never acquired rectal control at night. Every year since operation has suffered from an attack of renal infection. He has worked fairly regularly as an agricultural labourer. In December, 1927, ten years and two months after the second ureter was transplanted, he was 29 years of age and was quite well; weighed 10 st. 7 lb., was 5 ft. 10 in. high, and had good rectal function and control during the daytime.

Case 4.—Epispadias with total incontinence. Transplantation of both ureters into recto-sigmoid in one stage. Death from peritonitis and pyelonephritis.

E. L., female, age 20. (Reg. No. 13712.)

HISTORY.—This patient was admitted complaining that she had never been able to retain more than a few drops of urine since she was 3 years old. She was found to be well developed and nourished. All the urine had been allowed to soak into the garments and her condition was distressing and pitiable. No previous operation had been attempted. The local condition was that of epispadias as found in the female, the remaining urethra and vaginal wall being patulous and without muscular tone.

OPERATION, April 3, 1917.—General anæsthesia. Middle-line incision from just above the umbilicus to an inch above the pubes. The right ureter was exposed, lifted from its bed, divided, and implanted into the sigmoid by the method of Stiles. In this case the pelvis was roomy and the parts very accessible. The operation had been so easy and looked so satisfactory that it was decided to carry out the same method on the opposite ureter there and then. The left ureter was therefore implanted several inches higher up in the bowel. At this stage it was observed that there was a slight kink in the sigmoid opposite the sacrum, which might at any time give rise to obstruction, so the bowel was adjusted and fixed by some additional sutures. The whole operation occupied sixty-five minutes, the patient being an excellent subject for anæsthesia and the abdominal wall being perfectly flaccid throughout.

PROGRESS.—The patient stood the operation very well, but the next day the pulse was rapid and weak, and the tongue dry, furred, and brown, while the temperature was subnormal. There was no abdominal distension, but much tenderness on palpation. She passed urine per rectum, together with a good deal of blood. On the following day she said that she felt better. The temperature was beginning to rise. Saline and whisky were administered intravenously, with further improvement. On the third day the temperature was 102°, and the pulse still very rapid. There was a severe rigor about middle day, and

in the evening the patient complained of pain over the right kidney. On the seventh day the patient was still very ill, but there were no more rigors. The wound was dressed and found to be satisfactory. Urine was passed frequently per rectum and there were no uræmic symptoms. Large hot foments were applied over both kidneys, and 30 gr. of potassium citrate were administered four-hourly. The patient had a good night and the temperature was slightly better. The next day, the eighth, she complained of more pain over both kidneys and both sides of the abdomen. She felt sick, and complained that she was unable to see clearly. Saline with whisky was injected subcutaneously. The evening temperature and the pulse were both improved, and colour and respiration were better. The pain was lessened but there was still vomiting. The patient had a fair night and slept about five hours in stages, and on the ninth day she looked and felt better. The pulse was as before, but the temperature was subnormal. The same evening the patient had a further rigor, and afterwards she became very cold and breathed badly. From this time the condition steadily became worse, and the patient gradually sank and died just eleven days after the operation.

POST-MORTEM EXAMINATION.—Only a hasty examination could be made. The distended small intestine was adherent over the pelvis, and when separated disclosed a large abscess around the sigmoid in the region of the anastomosis. The left ureter was gangrenous and had separated from the bowel, leaving an aperture the size of a threepenny piece in the gut where the anastomosis had given way. The left kidney was greatly enlarged; the pelvis contained a large quantity of pus, and there was evidence of ascending infection from medulla to cortex. Microscopically, this kidney showed acute inflammatory change throughout, evidently of septic origin. The right ureter was in position, but the wall of the gut and outer coat of the ureter had both taken part in the inflammatory process. This kidney showed slight congestion, but no marked change in medulla or cortex. Microscopically there was acute parenchymatous inflammation but no evidence of septic invasion.

Case 5.—**Ectopia vesicæ. Transplantation of both ureters in two stages at three weeks interval. Perinephritic abscess. Recovery.**

V. K., female, age 6 years. (Reg. Nos. 9591 and 9869.)

HISTORY.—This patient had been under observation since she was a day old. Her mother gave the baby devoted attention, and she made good progress throughout, thriving like a normal child. When admitted for operation at 6 years of age she was well nourished and in good condition, but very nervous and shy. There was complete ectopia, with cleft of the mons and vulva and wide separation of the pubes.

FIRST OPERATION. Aug. 28, 1917.—General anæsthesia. Patient placed in Trendelenburg position, mid-line incision. The left ureter was implanted into the rectum by the method of Stiles. Left oöphorectomy also carried out, and the wound closed by through-and-through sutures without drainage.

PROGRESS.—The child stood the operation quite well and seemed very little disturbed. On Sept. 1 there was a little pain in the left side with a rising temperature. By Sept. 4 the pain had disappeared after treatment by the local application of heat. The temperature was down and the patient picking up nicely.

SECOND OPERATION, Sept. 18, 1917.—Old incision re-opened. The site of the previous anastomosis was examined and found to be shut off by omental adhesions. An operation similar to the preceding was performed on the right ureter. The gut was made to overlie the exit of the ureter from its retroperitoneal bed. Wound closed by through-and-through sutures without drainage.

PROGRESS.—After this operation the patient picked up well, but there was some vomiting. From the first she used the bed-pan about four times during the night and had no wet beds. About Sept. 28 she developed pain in both kidney regions. The pulse was rapid but the temperature was not elevated. The abdomen became distended; there was vomiting and some nocturnal incontinence. The patient gradually improved, except that she got steadily thinner and developed a slight evening rise of temperature. She required to use the bed-pan about every two and a half hours. As the condition was not very satisfactory the abdominal wound was opened with sinus forceps and about 10 oz. of pus evacuated. By Nov. 7 the patient was looking better; there was no pain or discomfort and no more wet beds. There was still a little discharge from the lower end of the wound, and for two days an elevation of temperature.

OPERATION. Nov. 20, 1917.—Incision again opened up at the lower end, and a further abscess found in the abdominal wall. Under the anæsthetic a mass in front of the right loin was made out, possibly a perinephritic abscess. Another incision was made close to the right iliac crest, evacuating a retroperitoneal collection. A rubber drain was passed through both incisions. By the end of November the child was so much better that the

drains were removed. There had never been any discharge of urine from the incision. Urine was passed every three hours or thereabouts, and there was full continence. A week later the temperature ran up to 102·2° and the pulse to 120. The child had headache and felt sickly. The abscess was practically healed, but the child was still very thin, the condition being attributed to kidney infection. After this the patient gradually improved and was soon able to leave the hospital. She was seen from time to time and steadily improved, so that in due course she was able to go to school.

In November, 1920, she came to hospital for examination. She was then 9 years and 8 months old, and a well-developed, healthy-looking child, able to take ordinary food, and was never sickly. Weight, 4 st. 6 lb. She was attending school and had risen to be a monitor, and was behaving much as other schoolgirls of her age. The rectum was emptied about five or six times in twenty-four hours, four times during the day, and at night about 3 a.m. and again at 7.30 a.m. She awakened and got up herself. Sometimes at night there was a little incontinence, but never by day. On one occasion the urine passed in twenty-four hours was measured, and found to be 33 oz. Once since leaving hospital she had had an attack of pain on the right side, which disappeared in a few hours after the application of hot flannels, and she was all right the next day. Twice or thrice the doctor had attended her for colds or for fainting at school.

In April, 1921, the patient was admitted to hospital in order to have the mucous membrane of the bladder removed. The opportunity was taken of examining the bowel in the hope of inspecting the orifices of the ureters. There were no signs of irritation about the anus and the sphincter was competent. Under general anæsthesia a soft rubber catheter was introduced into the rectum and about half an ounce of clear, odourless urine, mixed with some muco-pus, was withdrawn. The sigmoidoscope was introduced and the bowel distended. The lining membrane of the rectum was seen to be perfectly clean and normal. The two ureteric orifices were found. The one on the right side was very much reddened, and no urine was seen to come from it. That on the left was more clearly seen, and appeared as a small depression in the mucous membrane. There was no hyperæmia in its neighbourhood, and urine was seen coming from it in a series of spurts, which enabled its location to be certainly identified. After this examination the patient was turned on her back and the bladder dissected up from the abdominal wall. There was a good deal of troublesome hæmorrhage. Catgut sutures placed horizontally helped to close the hiatus which remained. The labia were then partially undercut, the incisions being carried well up on to the abdominal wall to relieve the tension. These were then opposed with silk-worm gut. The clitoris was bifid, the vaginal orifice was almost vertical, and was about the size of a normal adult female urethra. It was incised backwards and its mucous membrane stitched to skin. It was very difficult to get the halves of the vulva together on account of the wide separation of the pubes. It could only be done by wide lateral undercutting, and even then there was considerable tension. The patient was under anæsthesia for an hour. She was not unusually upset, and made an uninterrupted recovery from this interference. On this occasion the urine was examined bacteriologically, but the flora was indescribable, and the colonies were much too numerous to count.

In March of 1922 the girl was very well and was developing rapidly, hair commencing to grow on the vulva. Continence was good and she never wet the bed. In 1925, at the age of 14, she began to menstruate normally. Early in 1926 she was better than ever before. In August of the same year the blood-urea was found to be 55 mgrm. per 100 c.c. This definitely raised content in a person of her age was taken by Dr. Spence to indicate some slight impairment of renal function. At this time a further plastic operation was carried out for the restoration of the vulva, the mons being still deeply grooved and some-what unsightly. General ether anæsthesia was again employed, but the patient was in no way upset and made a normal recovery. During 1926 she had a febrile attack with pain in the right kidney region and was laid up for two weeks. While thus affected she required to empty the rectum more often. In August, 1927, a year later, she was quite well and was able to spend her holidays from home. She then wrote, " When I was younger I could not get away like other girls of my age, but now that I am better I am pleased to say that I can do so. I have spent my holidays in Edinburgh this year and I feel quite well."

In December, 1927, she was splendidly well in every way, and weighed 8 st. 9 lb. and was 5 ft. in height. She looked robust and was bright and cheerful (*Figs.* 93, 94) and was learning to be a hairdresser ; she left her home at 3 p.m., went a car journey of half an hour, and did not get home until 9.45 p.m. During this time she only emptied the rectum once. In the ordinary way she rises at 8.15 a.m. and empties the rectum, not again until about 12, then at 3, just before going out as a matter of pre-caution, and after that not until 9 or 10 o'clock. She usually gets up once at night, never more than twice, and never wets the bed. She was not able to say whether she can pass wind, but has not observed and has certainly not been bothered. The opportunity

FIG. 93.—*Case 5.* V. K., at 16 years of age, 10 years and 2 months after operation. Height 5 ft., weight 8 st. 9 lb. The photograph shows the general nutrition and development.
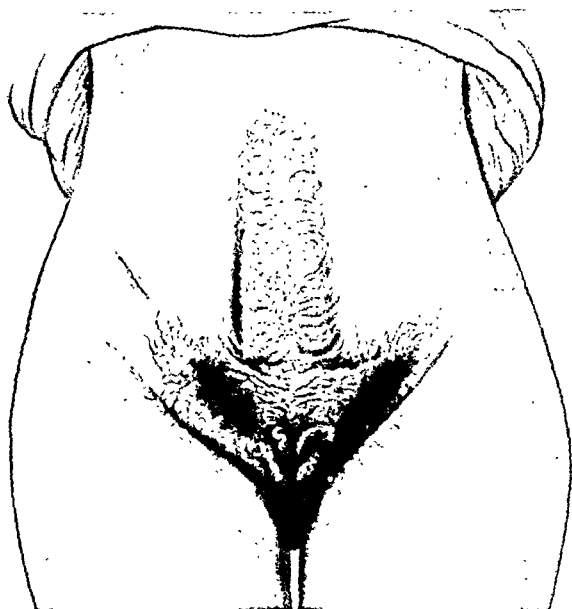

FIG. 94.—*Case 5.* V. K. Drawing made at age of 16, showing the wide abdominal scar and the final result of the plastic operations carried out for the removal of the bladder and the repair of the vulva. Just below the right anterior superior spine is the scar of the incision made for the evacuation of the extraperitoneal abscess which followed the transplantation of the second ureter. There is wide separation of the pubes.

was taken to make a sigmoidoscope examination. The anus was normal and was tightly contracted. The mucous membrane of the bowel looked normal but was moister than usual; no other notable change. Although it was possible to make a careful examination this time the ureteric orifices could not be found, though urine was obviously freely entering the bowel. The evacuation is, as a rule, a mixture of fæces and urine; sometimes clear urine is passed, and very occasionally a solid motion. She walks well without any waddle. The X-ray picture shows wide separation of the pubes.

Her family medical attendant was written to about the febrile attacks, and his reply of Jan. 11, 1928, is as follows: "This patient, before the ureters were implanted into the rectum, used to have acute attacks of abdominal pain. Situation of pain was indefinite—she was of course very young then—attacks used to last from one to two hours, and relief was obtained by placing her in a hot bath. Attacks came on about every two months. After ureters were implanted in rectum she had four or five 'attacks' at about four-monthly intervals. She was shivery and cold, had to be put to bed, and complained of mild, aching pain in her loins. There was tenderness over the kidney region. Poultices were applied to the loins and a diaphoretic mixture given. In three to four days she was quite well."

Summary.—Case of ectopia vesicæ in the female, under observation from birth to the age of 6 years, when operation was carried out. Transplantation of ureters into recto-sigmoid in two stages at an interval of three weeks. Perinephritic abscess opened during convalescence. In December, 1927, ten years after operation, the patient was 16 years old. She weighed 8 st. 9 lb., and was 5 ft. in height. She was well in every way and had perfect rectal function and control.

(NOTE.—In October, 1928, this patient had an unusually bad pain on the right side. X rays disclosed a renal calculus.)

Case 6.—Ectopia vesicæ.   Transplantation of ureters into recto-sigmoid.   Death from peritonitis.

J. T., male, age 13.   (Reg. Nos. 11980–11981.)

HISTORY.—This patient was admitted on March 4, 1919, with ectopia vesicæ, with all its discomforts. The boy was in good general condition. No previous operations.

OPERATION, March 14, 1919.—Median incision. Left ureter exposed and transplanted into the sigmoid by the method of Stiles. The ureter was greatly dilated and thin-walled. A portion of the corresponding vas was excised.

PROGRESS.—After operation the patient had a mild attack of pneumonia. He also suffered from very slight diarrhœa, but urine was soon passed per rectum at volition of the patient. By May 13 he was very well; weight 5 st. 11 lb. 7 oz., height 5 ft. 2½ in.

SECOND OPERATION, May 16, 1919.—The right ureter was transplanted into the sigmoid; it was dilated and thin-walled like its fellow. The site of the left anastomosis was obscured by adhesions, but it was observed that the bowel at this point was a little narrowed. A portion of the corresponding vas was also excised.

PROGRESS.—The patient stood the operation splendidly, and was quite well the next morning. The same afternoon blood was noticed in the evacuation. On the second day the patient was not so well and began to vomit a large quantity of dark green fluid. By the third day the boy was very ill. There was frequent vomiting, he complained of pain in the abdomen and on defæcation, and there was some rectal incontinence. There had been some more blood in the evacuation and some bleeding from the wound. On the fourth day the patient had less discomfort, was quiet and free from pain. The temperature was normal, but the pulse was 120–130 and very small and feeble. In the early morning he looked very ill, with sunken face, black nostrils, and cyanosis. The tongue was moist and only slightly coated. There was no distension of the abdomen and no tenderness either in front or in the loins. He suffered from rectal incontinence, but on introducing a catheter through the sphincter about 4 oz. of highly alkaline urine and fæces escaped. Catheter left *in situ* for drainage. At night he was much worse, frequently sick and with a very feeble pulse. Death occurred on the fifth day after operation.

POST-MORTEM EXAMINATION.—An autopsy disclosed general peritonitis, apparently originating in the neighbourhood of the right ureter, which had been transplanted last. A closer examination showed that the ureter had been penetrated by the fixation sutures so that there must have been leakage of urine into the peritoneum. Unfortunately there is no record of the condition of the kidneys.

Case 7.—Complete epispadias with incontinence. Transplantation of ureters into recto-sigmoid in two stages, at one and a half years interval. Recovery.

W. P., male, age 5. (Reg. Nos. 13713 and 13714.)

HISTORY.—This patient was an only child. He was a small delicate baby who only survived owing to the devoted care of an excellent mother. During the first twelve months of his life he was three times in hospital in Leeds, but no operation was carried out. The child was under observation for some time, and as the parents were most anxious to have the operation carried out the first stage was performed at the age of 5½ years, despite the fact that he was small for his age, fair-haired, and delicate.

OPERATION, Aug. 16, 1918.—General anæsthesia. Median incision below and to the right of the umbilicus. The parts were very small, and the great tendency of the intestine to escape from the abdomen was very troublesome. The right ureter was exposed low down and divided, the distal portion being ligatured. Anastomosis into the rectum was carried out by the method of Stiles, about one inch of the ureter being buried in the wall of the gut. The vas on either side was exposed from the pelvis, and divided. The abdominal wall was closed by means of figure-of-eight silkworm sutures. No drainage was provided. A large rubber catheter was passed into the bladder to prevent, if possible, the urine from flowing over the abdominal wound. The operation took about an hour and the boy was rather shocked towards the end.

PROGRESS.—The day after operation the condition was satisfactory. On the 18th and 19th the patient was not so well, being very restless and vomiting frequently. By the 21st the patient had not had the bowels moved, so 1 gr. of calomel was given at night and another on the following morning. That day there was some movement of his bowels. He was still very restless, but there was no vomiting. On the 23rd, just a week after operation, the patient was obviously very ill. It was considered that he had developed some pelvic peritonitis, either the result of retroperitoneal suppuration or of some sloughing of the ureterocolic anastomosis. Under a minimum of anæsthesia the lower sutures in the abdominal wall were removed. As soon as the peritoneal cavity was reached there was a rush of offensive urine followed by pus. Drainage was provided and the boy steadily improved in every way. Pus and urine continued to be discharged from the abdominal wound, but in spite of this he did pass some urine per rectum and he was soon well enough to return home.

After leaving hospital the sinus closed in a few days, and the boy steadily and slowly improved though he continued small and delicate. In February, 1920, he weighed only 2 st. 7 lb. 3 oz. With a view to carrying out the second stage the patient was readmitted in May, 1920. He was still very small for his age, weighing 2 st. 8 lb. 12 oz., and looking frail and delicate.

SECOND OPERATION, May 22, 1920.—The abdomen was re-opened in the mid-line and loops of small bowel were found covered with thin omental adhesions and adherent to the right side of the pelvis, thus obscuring the site of the old anastomosis. The pelvic colon was separated from the pelvic wall and drawn towards the right. The left ureter was then divided about the level of the upper end of the internal iliac artery, and was implanted into the sigmoid by the method of Stiles. There was no tension, the ureter lying comfortably against the bowel wall. This time a small rubber tube was brought from the region of the anastomosis and by a retroperitoneal route through an independent puncture in the left iliac fossa. The abdomen was again closed by figure-of-eight sutures. A large catheter was left in the rectum.

PROGRESS.—For the first three days the condition gave no cause for anxiety, but on the fourth day it was noticed that the patient had developed a rash, slightly papular and with a definite inflammatory edge ; there was itching and slight rise of temperature. It was present on the arms, legs, and feet, and a large patch appeared on the forehead. In a couple of days the rash had almost gone, leaving a slight, coppery pigmentation still visible on the limbs. By this time the patient looked very well. The rectal tube was removed and was followed by a good movement of the bowels. By the 29th the rash had completely gone, and the drainage tube was removed from the abdominal wound, which was healthy except for slight irritation round the second top stitch. As far as could be ascertained the boy had rectal incontinence.

On the 31st, that is nine days after the operation, the patient was fairly well but complained of a little pain in the left side and had some temperature and was flushed. Until this he had taken food fairly well, but now he was a little out of sorts and very thirsty. On the 10th day following operation there was some slight urinary leakage from the site of the abdominal drainage tube, and this continued for a week, when it stopped spontaneously. During the next day or two the temperature was up to 101° and the boy was chesty. On June 7 it was noted that the patient had been much better during the previous three days. By June 10 he was well in himself and had a good appetite. Rectal continence was much improved, and he now never wetted the bed during the day, and only about twice at night.

In November, 1920, the report was very satisfactory. The general health was much improved ; he took his food well and always had a good appetite. He was attending a small private school and playing games with the other children. The rectum was emptied about six times during the day and about twice or thrice at night. The boy emptied the rectum when he went to bed about 9 o'clock, and when the parents retired at 11 o'clock he was wakened for this purpose, and again at about 3 a.m. If the intervals were longer than this there might be a slight accident, but not always. At 5 a.m. or thereabouts the boy awakened himself and emptied the bowel, after which he slept in comfort until 8 o'clock when he rose. The parents were delighted with the result of the operation.

In July, 1924, the boy was looking better than ever before. He still had to empty the rectum about twice each night. There was some weakness and a tendency to ventral hernia about the centre of the abdominal scar. In August, 1925, the patient was 12 years of age. The mother reported that for two or three months he had not been so well. Every few days he was seedy and not so lively as usual. There was no shivering or vomiting, but he complained of tenderness in the left loin. When seen he looked very well and was quite plump and a good colour, but there was slight tenderness in the left kidney region, though the organ was not found to be enlarged. Rectal continence was good and the sphincter competent. He was given a teaspoonful of potassium citrate every twenty-four hours, after which the symptoms rapidly disappeared and did not recur. Concerning these attacks, Dr. Stitch reported as follows : " This boy had two febrile attacks with pains in loins and malaise. In the first attack we attended him from May 13, 1925, until May 20. In the second we attended from Aug. 6 to 19, 1925. He has been quite well since so far as we know, and I often see him playing games with other boys, though he is rather quieter and less boisterous than the average boy. I think the latter characteristic is due to a studious nature which has been fostered by his disability." In February, 1926, the boy reported that he was better than ever before.
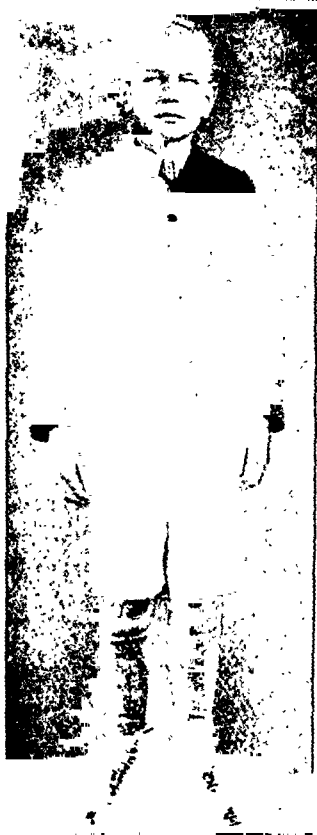
FIG. 95.—*Case 7.* W. P. Photographs at 15 years of age, 7 years after operation. Show good nutrition and development.

On Dec. 16, 1927, seven years after the last operation, he came up for inspection. He was then nearly 15, and was very well in every way and looked well nourished and healthy (*Fig.* 95). He had finished school, having reached the 6th standard, and was attending a Commercial College. He weighed 4 st. 2¾ lb. and measured 4 ft. 2¼ in. in height. The daily routine was much as follows : At 8.30 he rises, empties bowel, and has breakfast. Afterwards comes to Newcastle by train, goes to college, where he sits at his work until 12.45, when he goes to a café, ten minutes' walk, for dinner, and then for the first time since breakfast he empties the bowel. Occasionally during the course of the morning he does go to the lavatory. After dinner he returns to college, where he remains

till 4.15, when he goes a train journey of twelve minutes, then walks home—which takes him five minutes—has tea, and then, or just before, goes to the lavatory again. After tea he goes out to play for a couple of hours and takes part in any game that is going—football, cricket, etc. Afterwards does preparation until supper at 9, after which he evacuates the bowel. He goes to bed about 10, and awakens about thrice in the night to empty the bowel. He states that he can pass flatus independently of emptying the rectum and that there is never an accident. The evacuation is always urine and liquid fæces intimately mixed. Never voids a solid motion. The anus and sphincter are quite normal. Sigmoidoscope examination was not made as the boy was rather nervous about it. The evacuation contained 3 gr. of urea to the ounce. He sometimes gets pain in the left side, but only very seldom—about twice in the last two years. No tenderness or enlargement of the left kidney—i.e., where he has had the pain. The testicles are descended and well developed. X rays show a normal-looking pelvis except that the pubic bones are separated to the extent of 1½ in.

Summary.—Case of complete epispadias with total incontinence of urine in a very delicate type of boy. Operation at 5 years and 6½ years respectively. Long interval on account of pelvic infection with urinary fistula after the first stage. Since second operation has steadily improved in health and has been able to attend school, where he has done very well. Three years after operation had some attacks of renal infection which readily yielded to treatment. In December, 1927, seven years after operation, he was nearly 15 years of age, in splendid health, and with perfect rectal function and control.

Case 8.—Total epispadias with incontinence. Transplantation of one ureter into rectum. Recovery.

N. B., male, age 13. (Reg. No. 13489.)

HISTORY.—Patient complains that he cannot hold his water at all, and that " he wets his bed and his trousers." Has had this trouble ever since he was born. He states that he had pneumonia when he was 10 years old.

ON EXAMINATION. — Condition of epispadias with dorsal cleft down to pubes, the mucous membrane being exposed in the entire penile portion of the urethra. A forefinger can be introduced easily into the bladder. The patient has almost complete incontinence when up and about, but not marked when lying in bed. His clothes were constantly wet, smelly, and encrusted with phosphates. He was undersized, very anæmic, precocious, and apparently in good general health. No obvious cause for the anæmia was detected. For a week he was kept under observation, and as he appeared to be all right it was decided to operate.

OPERATION, Jan. 22, 1921.—Median incision above and below the umbilicus. The left ureter was exposed above the brim of the pelvis and divided, the proximal end being transplanted into the upper rectum by the method of Stiles. There was a small hæmatoma below the anas-

FIG. 96. Case 8. N. B. At 13 years of age he was completely incontinent. One ureter was implanted into the recto-sigmoid. Since that operation he has acquired continence and urinary control. Since this photograph was taken the local deformity has been repaired, and he now only presents a slightly bifid glans.

tomosis which was opened and the clot turned out. A fine rubber tube was brought through a separate opening from the site of the anastomosis.

PROGRESS.—Jan. 25 : No abdominal symptoms. Had a high temperature and quick pulse and was very tender over the left kidney. Jan. 31 : The boy was much better ; he still had a fitful high temperature, but was not tender in the left loin. Bad cough. Feb. 1 :

Patient's temperature continued ; tube removed. Feb. 6 : Wound healed ; never been any leakage. Feb. 7 : Definite tubular breathing and increased vocal resonance in the upper part of his left lower lobe. Dr. W. E. Hume reported massive collapse of the base of the left lung. March 19 : Boy generally very well, up and about and active. The incontinence not nearly as bad as before, and could fairly be described as halved. The left chest had not yet recovered ; there was still some collapse, and at the apex there was an area of localized crepitations, which Dr. Hume thought was evidence of tuberculosis. The spleen was palpable. Further operation was postponed.

Jan. 8, 1928 : This was the first time this boy had been seen or heard of since the operation. He is now big and strong, age 19 years, weighs 8 st. 9 lb. and is 5 ft. 4½ in. high. Plays football vigorously. He has a big appetite and eats one stone of bread a week. Says that now and for some years he has not suffered from incontinence. He has control over the act of micturition and passes urine like other men (his father says the water splutters about). The lad's statement was borne out by the fact that his shirt and other clothing were quite dry, and by his mother, who stated that his bed was never wet. Only empties rectum four times daily. Evacuation is always liquid. Penis very large and testicles well developed (*Fig.* 96). Recently had bad attack of pneumonia. The urine passed per urethram contains 1·8 per cent of urea ; that per rectum 0·5 per cent. When examined with the sigmoidoscope the rectum looked normal ; there was very little urine in the lower part, but it welled into the instrument from above the folds of Houston. The ureteric orifice could not be found.

A plastic operation was carried out for the closure of the urethra. This was satisfactory except for the region of the glans, where there was a little loss of tissue by sloughing. The patient was not in the least upset by this interference, and showed no evidence of renal abnormality while in the hospital.

Cases 9 and 15.—Ectopia vesicæ. Transplantation of ureters by Peters' method in one stage, Good recovery. Further operation for removal of mucous membrane of bladder. Transplantation of left ureter by method of Stiles. Recovery.

T. L., male, age 4 years 2 months. (Reg. Nos. 14199–17328.)

HISTORY.—The boy, the second child of healthy parents, was born with complete ectopia vesicæ. He was carefully looked after as a baby and throve well. When admitted to hospital he was found to be well developed in every way except for the local deformity. Wide separation of the pubes was very striking. There was no evidence of renal sepsis. The mucous membrane of the bladder presented an extraordinary villous condition, making it look like a tumour ; this condition only effected the parts above the trigone ; the latter was not involved, but was obscured by the overgrowth of villous processes from above. It was decided to carry out the Peters operation as being less dangerous in a child of this age.

OPERATION, Nov. 22, 1921.—General anæsthesia, open ether. The ureters were found with ease, and a No. 6 Jaques catheter, with the end cut off, was passed into each. Urine flowed freely from the left side, but none came from the right. The separation of the ureters from the bladder wall was difficult because the parts were overhung by the villous processes, and because of the free bleeding. Eventually about 1½ in. of each ureter were separated with a rosette of bladder wall round the orifice. The catheters were fixed to either ureter with a fine catgut suture. With a finger in the rectum the anterior wall of the latter was pushed forward and was divided transversely without opening the peritoneum. The ends of the ureters, with their catheters, were then turned into the rectum, the catheters being brought out of the anus. The incision in the rectal wall was drawn together with two or three interrupted catgut stitches, the ureters traversing the bowel at either extremity of the transverse incision. The operation took about half an hour and was well borne.

PROGRESS.—This was uninterrupted. There were never any bad symptoms, and nothing to suggest renal infection The bowels moved naturally, and there was no fæcal leak from the incision in the posterior bladder wall. There was never any flow of urine from the catheter on the right side, and on the 27th it came out of its own accord ; on the 28th its fellow, which had discharged freely, also slipped out. The child continued to do well, and left hospital on Dec. 13.

From the first this patient began to develop rectal control, but it was not complete, and he was always more or less wet at night. By January, 1922, his mother was able to report " the control in the daytime is now growing quite good, and there is no need to take any precautions other than continual watching and reminding. At times he can hold for three hours, his best days, at others every hour, but during the night we have not been so successful. Nevertheless, we do feel that he is making good progress in this respect." His appetite continues good, and there has been no sickness, but the boy seems very frail."

This patient was brought to see me on Oct. 19, 1922, because his father thought he

dragged the right leg more than he ought to do. I found just a little weakness of the leg, but nothing to cause the slightest concern. The boy appeared to me to be perfectly well, and his mother tells me that he sleeps and eats quite naturally. In the daytime he has perfect control. Not only so, but he can, if necessary, wait as long as twenty minutes in spite of an urgent desire to clear the bowel. The fæces and urine are sometimes mixed, but often passed alternately. At night time there is occasionally a little incontinence, but it is not bad. About every six weeks he gets some sort of attack, which may be associated with renal infection, but his mother tells me that he is never tender in the loins, and that he never vomits. Both the nurse and the mother informed me that when he has one of these so-called 'attacks' they notice a peculiar smell which is at times offensive. The exposed mucous membrane of the bladder gives him no trouble, and it was not proposed at the moment to interfere with it.

In November, 1923, the attacks were more troublesome, and were described as follows by his nurse : " Sickness, limp and tired, loss of appetite, temperature high, rapid pulse, dark rings round eyes, face pale ; occurring every ten days to a fortnight. Complains of pain in left hip ; always drags right foot. Sickness immediately after food, and is always hungry after sickness. Passes undigested food in motions ; colour yellow and sometimes greyish yellow. Urine sometimes highly coloured and rather offensive. Granulations (i.e., exposed bladder mucous membrane) sometimes very inflamed and sometimes almost white. Incontinent when sleeping during attacks, but at other times perfectly all right. Rectum emptied about five times each day. There is some offensive discharge from the bladder area." When seen he was looking thin and white, but the general nutrition was fair. Walks rather badly owing to wide pelvis. In December, 1923, he had rather a bad attack, but he soon picked up, gained weight, and was in wonderful spirits. During 1924 he had several attacks, but in July he was a good deal better, and weighed 3 st. 7 lb. By January, 1925, he was very fit on the whole, though still slightly feverish at times. Has had much better control during the last few weeks. He was seen in February, 1925, looking very well, though nervous.

Later, in September, 1925, it was decided to remove the mucous membrane of the bladder. For this purpose he had a general anæsthetic. The operation (Reg. No. 16910) took three-quarters of an hour. It was borne well, and there were no unusual features as far as the anæsthetic was concerned. The boy did not empty the rectum while going under the anæsthetic, but 2½ oz. of urine were drawn off at the beginning of the operation and 1¼ oz. at the end—i.e., the latter had accumulated during three-quarters of an hour. This specimen was clear except for masses of floating mucus. It smelt strongly ammoniacal and was very alkaline to litmus paper ; specific gravity 1012 ; only a faint trace of albumin ; no sugar ; urea 1·3 per cent. Bacteriologically the prevailing organisms were streptococci and bacilli of Morgan No. 1 type.

The skin about the anus was natural in appearance, and the sphincter as judged by resistance to the finger, and the rectum as seen by the sigmoidoscope, seemed normal. The latter was certainly not unduly dilated. The ureters were felt on the anterior wall 1½ in. from the anus. They were like two raised nodules in the midst, or rather on the surface, of an area of firm scar tissue. Seen with the sigmoidoscope they were paler than the mucous membrane of the rectum and just like two rosettes, and from time to time urine was seen to be ejected from the slit-like orifice on the summit of the left.

At this operation tenotomy of the right tendo Achillis was first carried out, and this was followed by excision of the mucous membrane of the bladder. The latter step was not difficult, but several vessels required ligature and bleeding obscured the field. The recti muscles could not be drawn together and the skin only to a slight extent. The testicles were noted to be both in the scrotum.

PROGRESS.—The boy did not appear to be upset by this interference, but when the gauze was removed from the bladder area it was noticed to be wet with urine, and it was soon obvious that there was a leak, a communication having been established with the rectum. An attempt was made to close this by suture on Oct. 10, the patient being under an anæsthetic for about twenty minutes. After this interference he had pyrexia, the temperature rising to 103°, and he was upset, but there were no symptoms to cause alarm.

The leakage continued, and on Nov. 4 another operation was carried out. A hole was found leading into the rectum which would admit the tip of the little finger, and into this hole the left ureter was prolapsed. Its open mouth was seen like a rosette at the upper margin—i.e., external aspect—of the hole, and from this urine freely escaped. The ureter was drawn into the rectum and fixed there by sutures, the hole in the rectum being drawn together. The closure looked satisfactory, but on Nov. 8 there was again obvious leakage.

On Nov. 18, under anæsthesia, a No. 6 rubber catheter was passed into the orifice of the left ureter, which had again prolapsed into the aperture, and about two drachms of almost pure pus were drawn off. The catheter was brought out of the anus and the hole in the rectum closed. The kidney was irrigated daily through the catheter. There was very

little reaction, and the boy continued to take food, etc., as usual. When the catheter came out at the end of a week it was obvious that the fistula was not healed, and the urinary leakage recurred.

In March, 1926, the bladder mucous membrane round the fistula was touched with the electric cautery. From this time onwards practically all the urine escaped from the fistula, and from time to time there was some fæcal discharge. He required to be changed two-hourly. His general condition remained quite satisfactory. In July, 1926, it was decided to transplant the left ureter into the sigmoid, the boy being in very good condition except for the urinary fistula.

OPERATION, June 12, 1926 (Reg. No. 17328).—The patient was passing an abundance of urine which could not be measured. Samples contained 10 gr. of urea to the ounce. Blood-urea was slightly increased, 36 mgrm. per 100 c.c., indicating some renal inefficiency. General anæsthesia, Trendelenburg position. The left ureter was found to be enormously distended, and looked like a piece of small intestine. An attempt was made to implant it into the bowel by the method of Stiles, but it could not be buried in the gut without using an inordinate amount of the latter for the 'tuck in'. It was, therefore, only buried at the point of anastomosis, and the latter was protected by stitching neighbouring appendices epiploicæ over the site. A rubber tube was brought from the neighbourhood of the anastomosis out through the parietal wound. Both kidneys were felt to be small, and the right ureter was about the same size as the left, but it was not interferred with. The incision was closed with figure-of-eight silkworm. The operation took just under one hour. The boy stood the interference very well, and suffered no immediate ill effects. On the 8th day he had a definite kidney reaction, with temperature up to 101°, sickness, and tenderness in the left loin. This soon passed off and he was able to leave hospital three weeks after the operation.

Unfortunately the urinary leakage continued much as before, and from time to time there was an escape of fæcal matter from the bladder fistula. By the early part of September his general condition was excellent, he was very active, and was taking his food well, though the local condition was very little altered. About the middle of this month he had a very severe renal attack, which came on quite suddenly and greatly alarmed his parents and medical man. It began with a rigor, the temperature running up to 103° with corresponding quick pulse. He was sickly, restless, and very thirsty. The urine was thick and very offensive, and contained much pus. He also had diarrhœa, and was very tender in the left loin. By the end of the month his condition was apparently normal again, but he had lost a good deal of weight and was white and pinched. This was the most severe attack from which he had ever suffered.

By December, 1926, he was about himself again; he had a good appetite and was regaining strength. He rides a bicycle, and has a companion with whom he plays and does lessons. There was perhaps a little less urinary leakage. The parents were averse to any further operation at that time, and in October, 1927, he was fitted with a urinal which kept him more comfortable during the day. Generally he was surprisingly fit and well.

Case 10.—**Total epispadias with incontinence. Transplatation of both ureters in two stages. Recovery. Intestinal obstruction three years later. Death from peritonitis.**

J. F., male, age 10¼ years at the time of operation. (Reg. No. 14482.)

HISTORY.—The patient was admitted to the hospital on March 19, 1922. He had suffered from incontinence of urine, with all its disagreeable consequences, since birth. His education had been very seriously retarded. Apart from an attack of measles at the age of four years, and of scarlatina some few months prior to admission, there was nothing of importance in the past history. He was, however, said to have 'never been very strong'.

ON EXAMINATION.—The general health appeared to be fairly good. Locally there was a condition of complete epispadias, and the resulting incontinence had caused excoriation of the skin over the lower abdomen and scrotum. The child's general health and the fact that he had successfully weathered the storms of the acute exanthemata showed a good resistance.

FIRST OPERATION, March 22, 1922.—General anæsthesia. Mid-line incision. The left ureter was approached by the transperitoneal route, mobilized, and after division low in the pelvis was transplanted into the sigmoid colon after the manner recommended by Stiles. A small rubber drainage tube was placed down to the region of the anastomosis; in addition a short tube was passed through the anus into the rectum to prevent distension. The child stood the immediate effect of the operation very well. It was followed by a fairly vigorous renal reaction as evidenced by the temperature, which reached its highest point, 100·8°, on April 4, with tenderness over the left kidney.

SECOND OPERATION, April 22, 1922.—General anæsthesia was again employed and the

old incision re-opened. The right ureter was implanted by a similar procedure into the sigmoid, drainage being employed as before. In addition it was observed that : (1) The previous anastomosis was well protected by the parietal peritoneum having been sutured over it ; (2) The left ureter could be felt in the bowel wall as a thickening, reminiscent of rectal polypus ; (3) The rectum appeared to be more distended and hypertrophied than at the previous operation ; (4) On opening the bowel after the application of the clamp, clear urine escaped. A good recovery was made from this operation, but a definite attack of renal infection again occurred, with some night fever up to 100·4°, which continued until May 1.
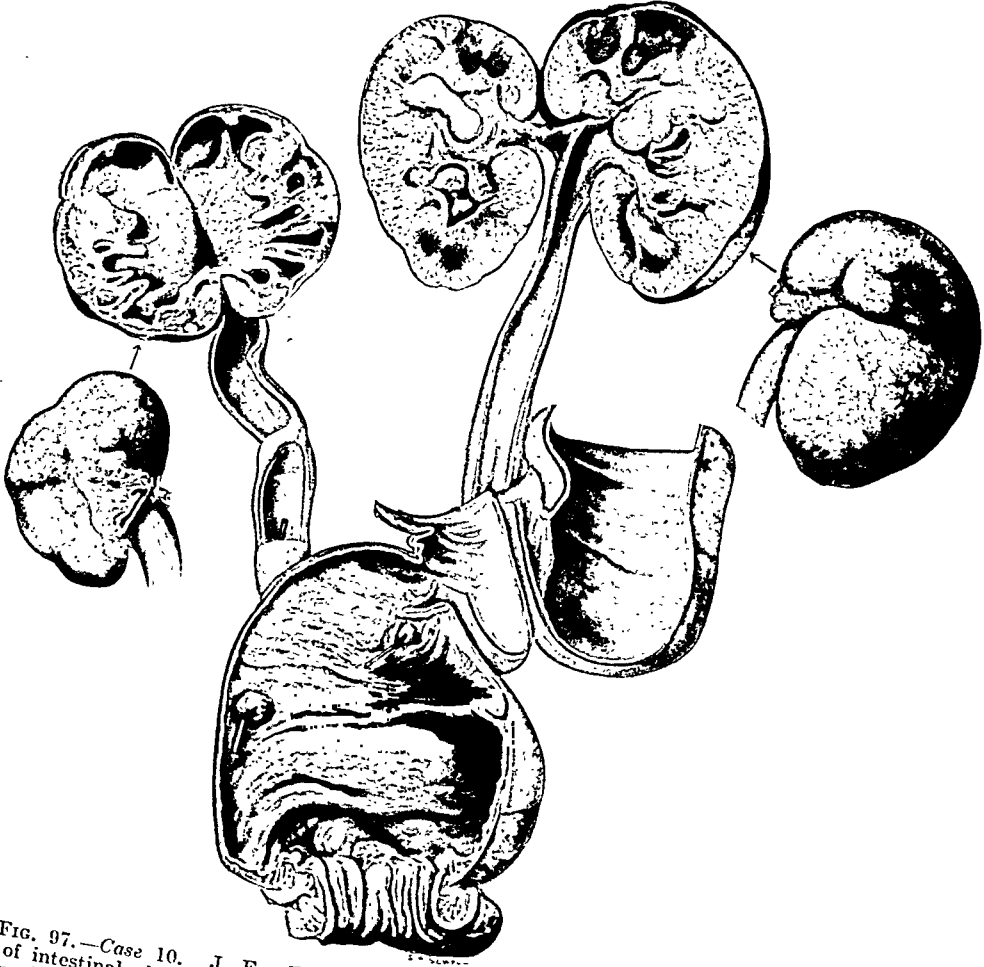
FIG. 97.—*Case* 10. J. F. The parts obtained after death from this patient, who died of intestinal obstruction 3 years and 3 months after implantation of both ureters. Intermediate health had been excellent. The right ureter is nearest the anus. The whole rectum is dilated, its wall is a little hypertrophied and the mucous membrane is covered with an inflammatory exudate which gives it a roughened shaggy appearance. Above the level of the ureteric orifices the surface appears normal.

On May 9, 25 oz. of urine were being passed from the rectum per diem. This urine had a specific gravity of 1010, a thick, dirty yellow appearance, a ropy deposit, an ammoniacal smell, and an alkaline reaction. On May 11, the entry in the hospital notes reads thus : " The patient is bright and happy. He passes urine per rectum with perfect continence about four times a day, and his bowels move comfortably about three times a day. The motion is a fluid one. His temperature and pulse are normal. He sleeps and eats well, and states that he feels better than ever he has done before. His abdominal wound is

healed perfectly and there is no sign of skin irritation left over the lower abdomen and scrotum." Urine from the rectum contained 4½ gr. of urea per ounce, i.e., 1·4 per cent. On May 16 he was discharged.

He remained perfectly well until May, 1925—three years later—when he was re-admitted with a history that during the previous twenty-four hours he had been suffering from recurring attacks of colic. Up to this time he had been attending school regularly, playing with the other boys, and taking food well—in fact, he appeared in every way normal. When seen in the hospital the boy was found to be in very good condition, and nothing abnormal was discovered on physical examination. The possibility of the attacks being renal in origin was at first considered, but the boy appeared to be perfectly well, the temperature was not elevated, there was no tenderness in the loins, and no palpable enlargement of either kidney. After two days, there being no recurrence of the pain, he was allowed to go home. A few days later, however, he was re-admitted, looking very ill and with evident signs of intestinal obstruction, with copious fæculent vomiting. The abdomen was opened by a junior colleague and the condition found to be an acute obstruction of the small intestine due to a band in association with tuberculous mesenteric glands.
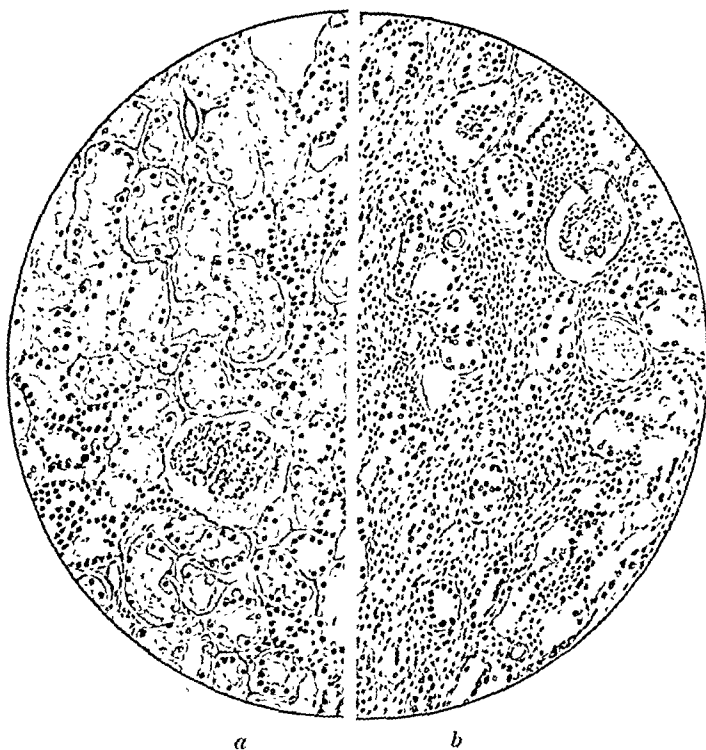
FIG. 98.—Microscopic sections of (*a*) left kidney and (*b*) right kidney. (× 86.)

It was necessary to make a lateral anastomosis. At the end of the operation there was a marked degree of collapse, but this was speedily overcome and for a couple of days recovery seemed assured. At the end of this time symptoms of peritonitis developed and the condition rapidly progressed, death occurring on the fifth day.

POST-MORTEM EXAMINATION.—There was a suppurative peritonitis binding the coils of intestine together. Some of the sutures at the anastomosis had given way and fæcal matter had escaped. The mesenteric glands were distinctly enlarged and caseous, some being definitely calcareous.

An examination of the recto-uro-genital organs resulted as follows (*Fig.* 97):—

The *rectum* was distended and its muscle definitely hypertrophied. The mucosa below the level of the ureteric orifices was coated by a shaggy exudate, and microscopically this region was found to be the seat of a mild catarrhal inflammation, whilst above this level the mucous membrane was smooth and appeared healthy both on naked-eye and microscopic examination. This slight degree of catarrhal inflammation could probably be

explained by the irritation consequent on ammoniacal decomposition of the urine. The right ureteric orifice was patulous, its mucosa having prolapsed, giving it a button-like appearance. Its wall showed a similar inflammatory change to that seen in the neighbouring rectal mucosa. The left ureteric orifice was very difficult to find, and was represented by a mere slit through which only a fine bristle could be passed. contrasting with its fellow, which admitted with ease a glass rod of much greater magnitude. The orifice of the left ureter could only be demonstrated by injecting fluid into the ureter above and searching for the issuing stream.

The *right kidney* was markedly shrunken and its surface deeply scarred. On section the organ consisted mainly of the dilated pelvis and calices. The condition was an advanced pyelonephritis. Microscopic examination (*Fig.* 98 *a*) of such renal tissue as remained showed extensive fibrosis, hyaline changes, and round-cell infiltration in the glomerular region. The tubules showed cloudy swelling. Areas of necrosis with accumulation of polymorphonuclears were also present, and in these there were a few bacteria.

The *left kidney* was of normal size. Its surface was also somewhat scarred. In the section some of the pyramids were much darker than the cortex. The cortex was swollen and the vascular markings stood out prominently. The pelvis and calices were slightly distended, the former merging imperceptibly with the ureter. Histologically (*Fig.* 98 *b*), the cortex showed areas in which some of the glomeruli were fibrosed, others showed slight lobulation, and in addition there was a round-celled infiltration. The tubules showed little change apart from cloudy swelling. The areas of fibrosis represented healing after a previous acute nephritis, probably a ' flare up ' after the transplantation operation. The appearances indicated the presence of a subacute inflammation of the kidney probably of the nature of an ascending pyelonephritis. A considerable number of fields exhibited relatively normal renal tissue. It is possible that the areas of necrosis containing bacilli, etc., seen in the right kidney represented a terminal pyæmic process, a consequence of the septic peritonitis.

The *ureters* when opened contained a quantity of purulent fluid. Both of them were dilated, but the wall of the right was the thicker. The right ureter was also shorter and more tortuous, and about its middle there was a definite annular narrowing. Histologically there was evidence of ureteric infection.

Summary.—A case of total epispadias with incontinence. Operation at $10\frac{1}{2}$ years of age. Transplantation of both ureters into recto-sigmoid at an interval of a month. Good recovery, and health with normal rectal function and control for three years. Death from peritonitis following an operation for acute intestinal obstruction. Right kidney in condition of pyonephrosis, the left showing evidence of recovered pyelonephritis.

Case 11.—**Ectopia vesicæ. Transplantation of one ureter. Death from peritonitis.**

E. H., female, age 2 years 7 months. (Reg. No. 15301.)

History.—This baby was a healthy child with typical complete ectopia. It had been under observation since it was a few days old and had thriven very well.

Operation, April 7, 1923.—Combined spinal and general anæsthesia. Trendelenburg posture. The intestine did not tend to prolapse. The left ureter was found very much dilated and full of urine ; it vermiculated freely. Peritoneum over it divided and about 2 in. of ureter mobilized. It was divided just above the bladder, and the distal end was allowed to retract into the retroperitoneal space. During this stage some urine from the upper end of the dilated ureter escaped into the peritoneum. The anastomosis to the bowel was made by the method of Stiles, great care being taken not to compress the ureter, and not to perforate the wall with the fixation sutures. The big ureter took up a good deal of bowel for the tucking-in process, and rather narrowed it in consequence. A tube was brought from the site of anastomosis to the outside.

The child stood the operation well, and recovered from the immediate effects without incident, but afterwards she never appeared to be quite right. The day following the operation, and for several days, she vomited continuously and looked very ill. Death occurred on the ninth day.

Post-mortem Examination (notes very poor).—General peritonitis involving infracolic area of the peritoneal cavity. This appeared to come from the wound. The junction between the ureter and the colon was intact. The pelvis of the left kidney was dilated and filled with purulent urine. There was extreme pallor of the renal tissue, but no obvious pyelonephritis. On microscopic examination the capsule was found to be definitely thickened and there was a moderate degree of chronic venous congestion. Irregularly scattered throughout the cortex, but more particularly in between the collecting tubules, there was an inflammatory cellular infiltration, the cells in which were chiefly

of mononuclear type. There were a few foci of inflammatory change due to abscesses which were undergoing repair. The infection appeared to be of ascending type. The right kidney showed marked dilatation of pelvis and ureter, but without infection.

Summary.—Case of ectopia vesicæ in a healthy child of 2 years and 7 months. Death from peritonitis after transplantation of one ureter. The infection appeared to arise in the region of the abdominal incision. The kidney on the transplanted side showed very definite ascending pyelonephritis.

Case 12.—**Ectopia vesicæ. Transplantation of both ureters in two stages at three weeks interval. Recovery.**

J. P., male, age 10 at time of operation. (Reg. Nos. 16250–16251.)

HISTORY.—The patient was the second child of a family of three, the parents not being very robust. On admission he looked thin and weedy, but seemed healthy enough and took food well. Weight 3 st. 2 lb. 9 oz. The ectopia was complete but there was no hernia. The pubic bones were widely separated (*Fig.* 99).
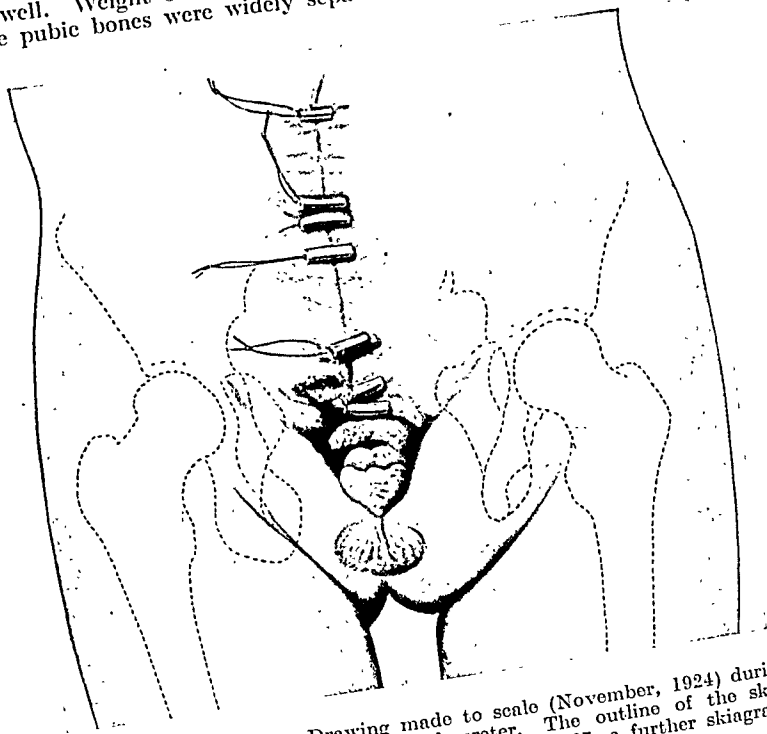
FIG. 99.—*Case* 12. J. P. Drawing made to scale (November, 1924) during convalescence from transplantation of the second ureter. The outline of the skiagram of the bony pelvis has been superimposed. In December, 1927, a further skiagram showed the same wide separation of the pubes.

FIRST OPERATION, Oct. 7, 1924.—General anæsthesia. Mid-line incision. Trendelenburg posture. Left ureter first dealt with. It was ligatured and divided close to the bladder, and the lower end carbolized and allowed to retract. About 1½ in. of ureter were buried in the bowel by the method of Stiles, and the region of anastomosis was fixed to the edge of the pelvic peritoneum by suture. A small drainage tube was brought from the neighbourhood of the anastomosis through the parietal incision. The operation took about one hour and was well borne.

PROGRESS.—This patient was very well, and there were no special symptoms, and certainly no cause for anxiety, until the morning of Oct. 9, i.e., two days after the operation. On this day he became suddenly ill, there was severe collapse with pale bluish lips, cold, clammy surface, and feeble pulse. The ward sister, an experienced nurse, thought that he might be going to die, and the house surgeon feared some internal hæmorrhage. The boy did not vomit, but felt sick. There was no complaint of pain. When seen by the author a diagnosis of left renal infection was made. The wound was dressed, and a

small tag of omentum was found prolapsed through the upper end, but this was not recent. The attack soon passed off and his condition steadily improved. By the 13th he was taking abundant liquid nourishment. Citrate of potassium in 15-gr. doses was given thrice daily. At first the emptying of the rectum was involuntary, but by this date he was developing control and asked for the bed-pan frequently. There was never any leakage from the abdominal drainage tube, and it was removed on the twelfth day. By the 26th the boy was very well in every way.

SECOND OPERATION, Oct. 28.—General anæsthesia. Abdominal incision re-opened. There were some few adhesions to the back of the incision. The lowest part of the sigmoid was closely adherent to the wall of the pelvis, covering the site of the first anastomosis and obscuring the ureter. The sigmoid above was quite free and normal. The rectum was
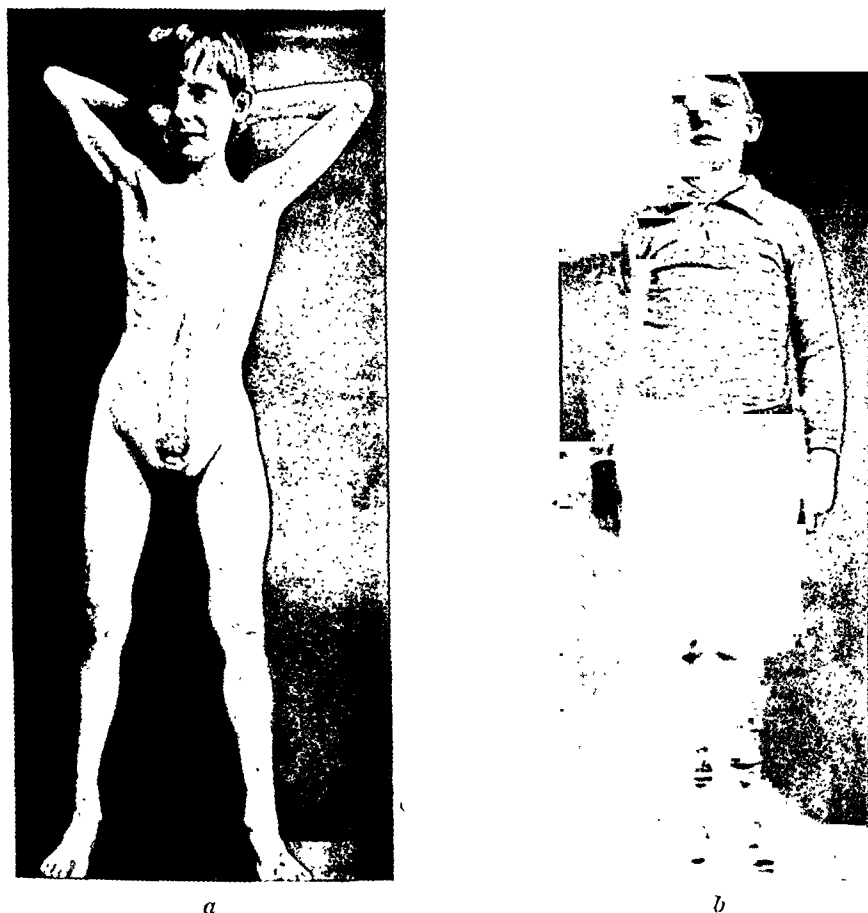
FIG. 100.—*Case* 12. J. P. Shows general development and nutrition
(*a*) before and (*b*) after operation.

much dilated, almost filling the true pelvis, and when later it was incised it was found to contain a good deal of liquid fæces. The right ureter was implanted into the bowel at a higher level by the same method, and the site of the anastomosis was fixed to the pelvic wall. The appendix, which was unusually long, was removed. Again a drainage tube was brought from the site of the anastomosis. The parietes were carefully sutured, and a large catheter was introduced into the rectum through the anus, through which liquid fæces at once escaped. The boy stood the operation well, and made an entirely uninter-rupted recovery without any symptoms to suggest infection of the right kidney. From the time of admission until the day before the second operation the temperature was persistently subnormal. The day after the second operation it rose to 100° and remained about the red line, or just above it, for a week. The boy left hospital on Nov. 15 in very good condition and with improving rectal tolerance.

On Feb. 14, 1925, the patient was seen again. He was very well, but still looked thin and delicate. His mother stated that the bowels were moved many times daily, that he sometimes wet the bed at night, but that the condition was steadily improving. In May, 1926, he was seen once more, and appeared to be in very good health, though still rather thin. Owing to some misunderstanding he had been refused admission to school, but as a result of negotiation with the Education Authority this was rectified and he was allowed to attend. A year later the schoolmaster reported that he was doing well and that he was quite of average intelligence. His condition in no way interfered with his attendance.

FIG. 101.—*Case* 12. J. P. Skiagram of pelvis. December, 1927. The distance between the pubes is $2\frac{11}{16}$ in., and between the ischial spines $2\frac{7}{16}$ in. This boy has a distinctive gait, but plays games with his fellows and does not complain of weakness.

On Dec. 12, 1927, the boy came up for inspection. He had greatly improved in every way, and looked plump and well. He weighed 3 st. $12\frac{1}{2}$ lb. and was 4 ft. $4\frac{3}{4}$ in. in height (*Fig.* 100 *b*). His mother stated that he had never ailed since he went home, and especially there have been no feverish attacks. He takes food well, is happy and cheerful, and goes to school regularly, playing games just like other boys. He walks characteristically with his feet a little apart, but there is no waddle. X rays show a well-

FIG. 102.—*Case* 12. J. P. The appearance of one of the ureteric orifices as seen by the sigmoidoscope : on the left at rest, on the right puckered and crenated during vermiculation and delivery of urine into the bowel.

developed pelvis, the pubes being separated to the extent of $2\frac{11}{16}$ in. (*Fig.* 101). The evacuation of the rectum still occurs rather frequently, and he wets the bed a little at nights. There is always a big stain, but the bed clothing is never soaked. He empties the bowel at 8.30 a.m., 10.30, 12 noon, 1.15, 4, 5.30, and just before going to bed about 8 p.m., and gets up three or four times each night. But there is a good deal of variation, and some days he does not go at 10.30 and 4, and only gets up once during the night. In this

respect he is invariably worse in cold weather. The evacuation is always liquid, and usually fæces and urine mixed ; it is very slimy and has a horrible odour. The boy states that he can pass flatus without any accident, and the mother says that his trousers are never soiled.

On the morning that he came to the hospital to report he emptied the rectum at 9.15, and at 11.40 he was requested to do so in order to suppy a sample. There was no desire, and when he tried he found he was unable to oblige, but about ten minutes later he voided a couple of ounces of fæces and urine mixed. On another day soon afterwards he passed at about 10.30 some 3 oz. of liquid fæces, at about 11.30 about 1 oz. of fæces and urine, and at 12.30 some 7½ oz., mostly urine. The anus showed no excoriation whatever, and the sphincter grasped the finger firmly. With the sigmoidoscope one ureteric orifice was seen at a distance of about six inches from the anus. It was like a papilla or nipple, rounded, smooth, and of a pink colour. Every now and again a wave of peristalsis passed over it, and just before urine escaped from its extremity it became shrunken and crinkled, the edges of the terminal orifice appearing bright red like a cherry (*Fig.* 102).

Summary.—Case of ectopia vesicæ in a boy, with total incontinence. Operation at 10 years of age. Transplantation of both ureters into recto-sigmoid at an interval of three weeks. Good recovery and improving health ever since. In December, 1927, he was 13 years and 4 months old, and in better health than ever before. Weighed 3 st. 12½ lb. and was 4 ft. 4¾ in. in height. Has perfect rectal continence during waking hours, but is sometimes wet at night.

Case 13.—**Ectopia vesicæ. Transplantation of both ureters in two stages at two weeks interval. Two years later plastic on bladder. Septicæmia. Death.**

W. B., male, age 4 years. (Reg. Nos. 16984–5.)

This patient was a small, weedy boy with complete ectopia (*Fig.* 103). The parents were most anxious to have him put right, and pressed for an early operation. There was complete ectopia, with wide separation of the pubes.

First Operation, Sept. 28, 1925.—General anæsthesia. Mid-line incision. Much trouble from tendency of small bowel to escape from incision. Right ureter easily found and implanted into sigmoid. It was slightly dilated and thickened. Self-retaining catheter in rectum. Drain from near anastomosis removed in a week. Rectal tube came out at the same time. Boy made a very good recovery.

Second Operation, Oct. 12, 1925.—Median incision reopened. Many adhesions of omentum and small intestine to parietes. The rectum was found very dilated—catheter passed into anus and much liquid fæces evacuated. The left ureter was two or three times the normal size, and very thick-walled, but it vermiculated naturally. It was divided and its lower end ligatured. A rubber catheter, size 8, was easily passed into the upper end, but it seemed too big, so a No. 6 was substituted, and fixed by an encircling ligature of catgut. No urine escaped either then or up to the time of completion of the anastomosis. This catheter was passed into the rectum and out of the anus and buried in the wall of the sigmoid with the ureter. This was not so satisfactory as in cases where the catheter was not used, and before completion the catheter was withdrawn until only its extremity ;remained in the ureter. At the end of the operation no urine was escaping from the catheter, and none could be sucked out with a syringe. The catheter was therefore removed, but a big tube was left in the rectum. The operation took an hour, and the boy was cyanosed throughout. He was chesty for a day or two, but this cleared up. The rectal catheter came out the day after operation, and afterwards the bed was

Fig. 103.—*Case* 13. W. B., at the age of 4, just previous *to the ureter implantation.*

continuously wet. He did not ask for the bed-pan. There was no renal attack, and the boy took food well. The abdominal drain was removed on the tenth day, and there was no leakage of urine from it. The patient went home three weeks after the operation. Just before leaving there were signs of rectal control developing, but the bed was still continuously wet. The mother was given instructions about the necessity of training the boy.

In February, 1926, the patient was quite well and continence was developing. In November he was still very well and was growing, but was extremely thin. The Education Authorities wanted him to go to school, and he began soon afterwards.

In August, 1927, the boy was very well in every way. He was attending school regularly and playing games just like other boys. He weighed 3 st. 2 lb., but looked very thin. The parents were advised to allow him to return to have the mucous membrane of the exposed bladder removed, and he was re-admitted for this purpose on Dec. 8, 1927. He still looked small and delicate and was very thin, weighing only 2 st. 12 lb. 3 oz. and being 3 ft. 11 in. in height. He was bright, cheerful, and intelligent, and took ordinary food very well. Both testicles were descended and normally developed. While lying in hospital rectal control was fairly good during the day for one to two and a half hours, but there was a good deal of incontinence at night. X rays showed separation of pubes to the extent of 2⅛ in. Examination on Dec. 13 of two separate samples of urine passed per rectum resulted as follows : First sample : Amount, 550 c.c. ; reaction, strongly alkaline ; albumin, present ; blood, present (pyramidon) ; urea, 1·31 per cent. Second sample : Amount, 250 c.c. ; reaction, strongly alkaline ; albumin, present ; blood, trace ; urea, 1·62 per cent.

It was intended to carry out the operation on Dec. 13, and the boy was taken to the theatre for that purpose and anæsthetized. Dr. Markham, the anæsthetist, remarked that he was rather a feeble subject, but nevertheless the boy struggled vigorously while going under the anæsthetic, which was A.C.E. followed by open ether. Altogether the administration lasted for thirty-five minutes. The rectum was first examined. The anus grasped the finger, but not vigorously, and it at once became patulous after the introduction of the sigmoidoscope. On introducing the latter about 2 oz. of urine escaped from the lower rectum, and it seemed remarkable that this did not escape during the administration of the anæsthetic. When the instrument was advanced further into the bowel, beyond the rectal shelf, several further ounces of urine gushed out, making a total collected of 6¼ oz., a good deal being lost. The latter came away almost clear, but with a lot of mucus, and following it a considerable amount of liquid fæces escaped. A careful and systematic search did not discover the ureters, and there was nothing to suggest where they might be hidden. Indigo-carmine, 1 c.c., was given by intramuscular injection, but there was no indication of blue discoloration in the bowel, and at the end of twenty minutes from its administration the search was discontinued. As this examination was rather prolonged it was not thought wise to proceed with the removal of the bladder, and the boy left the table at the end of thirty-five minutes in good condition. He very quickly recovered from this examination, and did not appear at all upset, certainly not more than is usual in ordinary children. Four days later the plastic operation on the bladder was carried out.

THIRD OPERATION, Dec. 17, 1927.—General anæsthesia was again employed, and he was under its influence for about forty minutes. The greater part of the vertical scar and the bladder were encircled by an incision and excised in one piece. The removal of the bladder opened up the cellular tissue of the pelvis, and left a deep hole leading to the recesses of the pelvic cellular tissue, as indicated in the drawing (*Fig.* 104). Several rather large vessels required ligature. The recti were widely separated, certainly to the extent of 1½ in. Their sheaths were opened and the muscles drawn together in the upper part, but this could not be completed towards the pubes as the tension was much too great. The deeper sutures were supported by flaps cut from the rectus sheath and turned over, by these steps the cavity left after removal of the bladder was diminished and partly covered, but it could not be completely obliterated. A tube was therefore brought from the depths, and the remainder was packed with iodoform gauze. The skin came quite well together except at the lowest part. This operation appeared to be well borne.

PROGRESS.—On the day following operation there was nothing to cause anxiety, but on Dec. 19 the boy looked very ill. There was frequent vomiting, and he was tender in the left flank. The pulse was very quick and of poor tension. Saline infusions with digitalin and strychnine were used. The next day he appeared to be a little better. The kidney regions were fomented and the boy took a good deal to drink. By night he was worse ; there was more vomiting, he looked very ill, and was restless. On Dec. 21 he was still very ill and the vomit was black. Until the previous night the bed had been soaked, but not since, suggesting suppression of urine. He was given water per rectum by the gravity method, and the nurse was astonished at the amount which entered the bowel and was retained. Unfortunately it was not measured, but it was much more than usual in a child, and certainly over two pints (a child of this age cannot be expected to retain more than about 10 oz.). There was no elevation of temperature, and the condition was looked upon as entirely due to renal insufficiency, and it was decided to expose the kidneys with a view to drainage, or decapsulation, or both, as indicated. About noon on Wednesday, that is, the fourth day after the operation, with local anæsthesia and a little gas and oxygen, this was carried out. Both kidneys were large and firm and there was no surrounding œdema. They were not unhealthy to the naked eye and the pelves were not dilated. In both the capsule was completely stripped, and this was done without any difficulty. The incisions were packed with gauze and left open, boric foments being applied. It struck the operator that by this method the kidneys could be directly fomented, or the patient
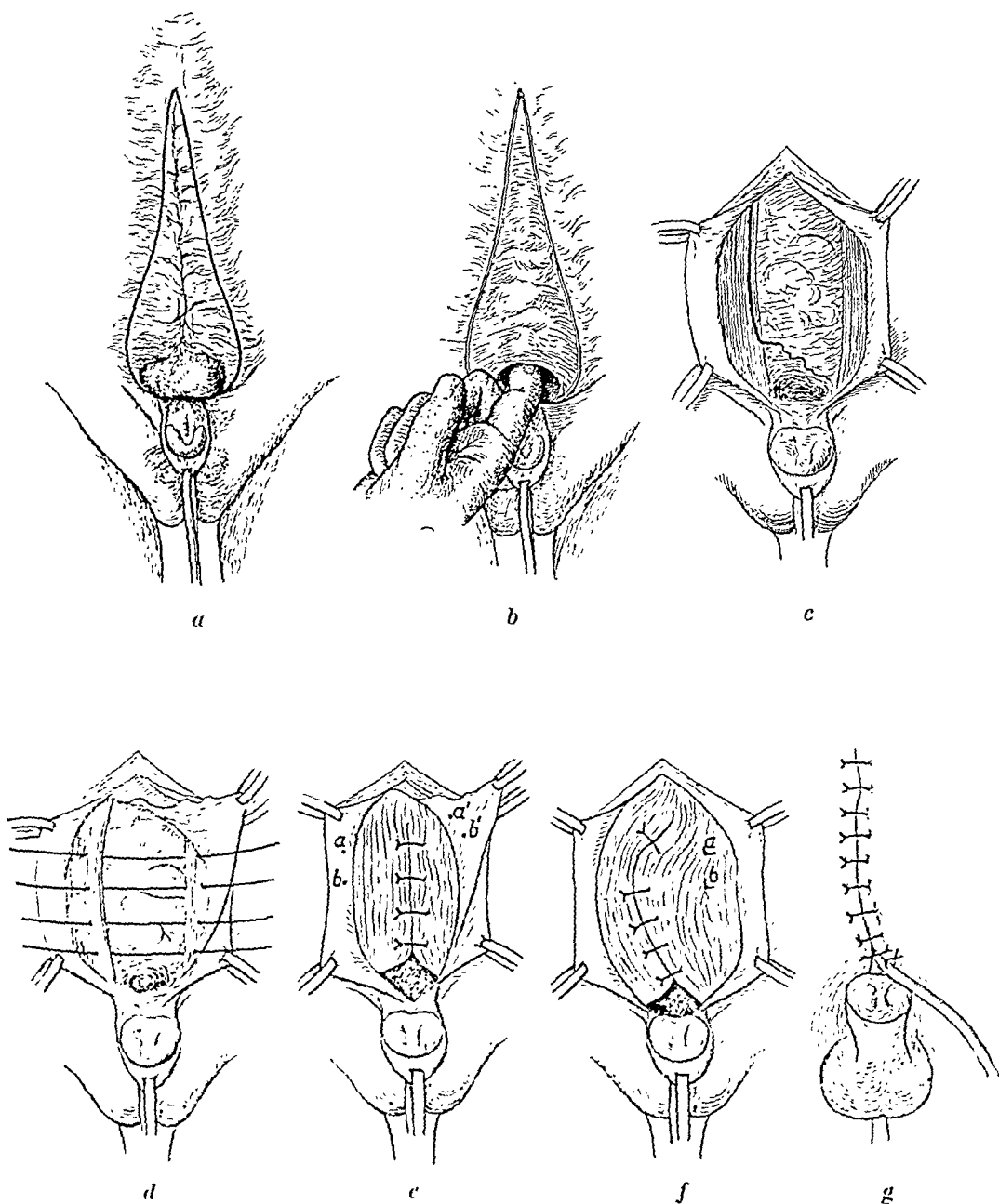
FIG. 104.—Case 13. A series of line drawings showing the steps of the plastic operation carried out. The lower part of the scar and the exposed bladder were first excised. In the next two diagrams the recti and much-stretched linea alba are shown. The recti are then shown drawn together, and finally the turned-up sheaths were over-lapped and fixed by suture, the points a, b, to a', b'. The drainage tube shown in the last diagram was brought from the depths of the pelvic cellular tissue.

could be put in a bath and the kidneys kept directly in contact with fluid of any tempera-ture. This operation took about twenty minutes and the boy did not appear to be upset by the interference. Unfortunately there was no improvement and he died at 7 p.m.

POST-MORTEM EXAMINATION.—The body was emaciated, and there was some decom-position about the median incision. The colon could not be distended per rectum—i.e., fluid would not run in, and simply regurgitated through the flaccid sphincter. There was no peritonitis. The whole pelvis was filled with contorted, dilated, and adherent sigmoid, rectum, etc., so that nothing else could be seen. The kidneys, ureters, and whole colon and rectum, with the anus, were removed intact. On separating the left ureter some pus was noticed in the retroperitoneal tissue near its lower end. This seemed to have travelled upwards, either from the neighbourhood of the ureteric anas-tomosis on that side, or from the extraperitoneal cavity from which the bladder had been removed. The liver was slightly enlarged, soft, and very fatty, owing to recent acute change. There was some purulent pleurisy on both sides and a very little pleural fluid; no bronchopneumonia, only a little congestion the result of general sep-tic invasion. The heart and peri-cardium were not affected.

The parts removed were sub-sequently carefully examined. The colon was filled with formalin from the ileum after suture of the anus. It was noticed that the fluid did not distend the ureters, and could not be made to do so even by manipulating the bowel, ureters, etc. The latter were filled by using a hypodermic syringe passed into the kidney pelvis on each side. When the fluid was subsequently removed from the colon it was carefully measured and found to be 1110 c.c.; some of the formalin had already escaped, and the bowel was not greatly distended, i.e., not tightly blown up. The condition of the parts as seen from behind is well shown in Fig. 105.

The rectum above the pelvic diaphragm was much thicker than below, and was pathologically hypertrophied.

FIG. 105.—Case 13. W. B. This patient died 2 years and 3 months after the implantation of the ureters. The drawing shows the parts removed after death as seen from behind.

The right kidney (Fig. 106) (the one which was anastomosed first) was slightly enlarged, measur-ing 3½ × 2 in. It showed definite hydronephrosis involving all the calices. The cortex was generally diminished and the surface was scarred in several places, and opposite the scars the cortex was narrowest. The dilated pelvis was thickened, reddened, and contained muco-pus, and was very hyperæmic towards the calices.

The right ureter was dilated to about four times the normal size. In the prepared specimen the widest part was half an inch across. As it approached the right side of the bowel it was much narrowed in comparison, but actually about normal, or only a very little bigger. Exactly 1¾ in. of the ureter was buried in the bowel wall. The track of the
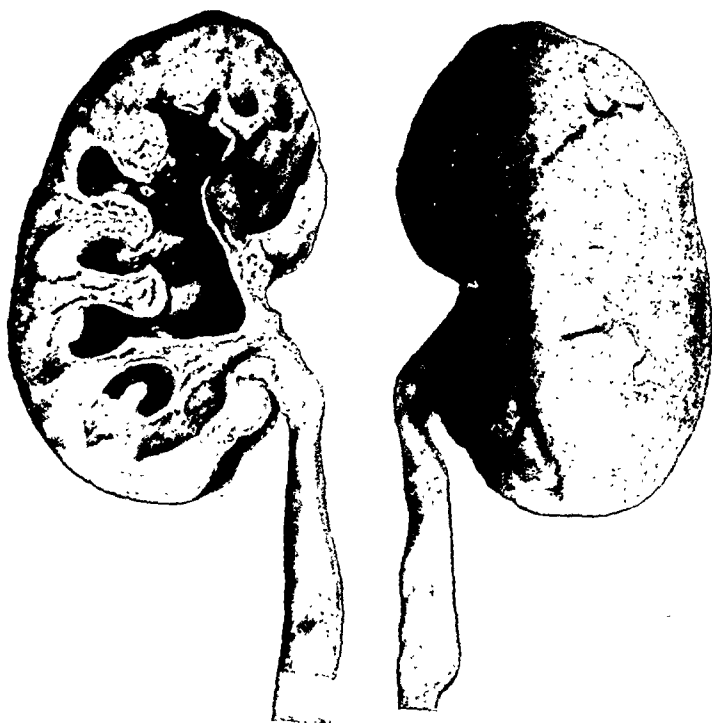
FIG. 106.—*Case* 13. W. B. Right kidney.

FIG. 107.—*Case* 13. W. B. Left kidney.

buried ureter could be seen from inside the bowel, which was raised up over it. The passage was oblique and gradual. The opening into the bowel appeared as a small depression, obscured by a mucous fold. In the specimen it was to the right and posterior. The part of the bowel into which the ureter opened was just above the pelvic diaphragm. The diameter of the opening was about $\frac{1}{15}$ in. or smaller. At first it appeared slit-like, but was dilated during the examination. This opening was quite hidden, and was only demonstrated after passing a probe down the ureter from above (see Fig. 120).

The left kidney (Fig. 107) was slightly smaller than the right. The pelvis was scarcely, or very little, dilated, and not in the least hyperæmic. The kidney substance looked healthy, but the cortex in the lower half was considerably diminished. The surface was scarred, but to a lesser extent than the right. (In both cases the capsule stripped very readily during life.) The microscopic appearances are shown in Fig. 108.

FIG. 108.—Case 13. W. B. Microscopic appearances of (a) right and (b) left kidneys. (× 60.)

The left ureter was about half the size of the right; it opened into the bowel to the left side of the bowel, and behind and at this point was considerably narrowed. The opening into the bowel, as seen from the lumen of the latter, was like a circular rosette raised at least ¼ in. from the surface of the mucous membrane. It was a little more than that in diameter, roughened on the surface, and like a wart or closely packed polypus (see Fig. 120). It opened into the bowel opposite the internal iliac artery, above the pelvic diaphragm. Two inches of this ureter were buried in the bowel wall.

By measurement it was found that the right ureter opened into the bowel 3½ in. from the anus, whereas the left was 8 in. from that point—i.e., their orifices in the bowel were 5 in. apart, and were separated by a complete bend of the bowel, closely and firmly fixed by adhesions.

The rectum, below the pelvic diaphragm, was ballooned and thin-walled, with what looked like normal mucous membrane. The bowel (? upper rectum, lower sigmoid) above the pelvic diaphragm was very definitely dilated, thicker in its wall, and with reddened mucous membrane, in contrast with that in the bowel in the compartment above into which the left ureter opened. The remainder of the colon looked normal from the outside, though it was much larger than would be expected in a child of the same age. It measured 26 in. from the ileocæcal valve to the commencement of the sigmoid. The latter was so coiled and adherent that the length of it and the rectum could not be ascertained.

Case 14.—**Ectopia vesicæ and double inguinal hernia. Transplantation of one ureter by the method of Peters. Septic dermatitis and cancrum oris. Death.**

J. M., female, age 1 year 4 months. (Reg. No. 17407.)

HISTORY.—This child was the youngest of a family of five ; she had been brought up on Glaxo. The parents were in very poor circumstances, and were more distressed about the encumbrance of the child than its welfare. It was quite obvious that they could not, or would not, be bothered with the child in its abnormal condition. Until the age of 7
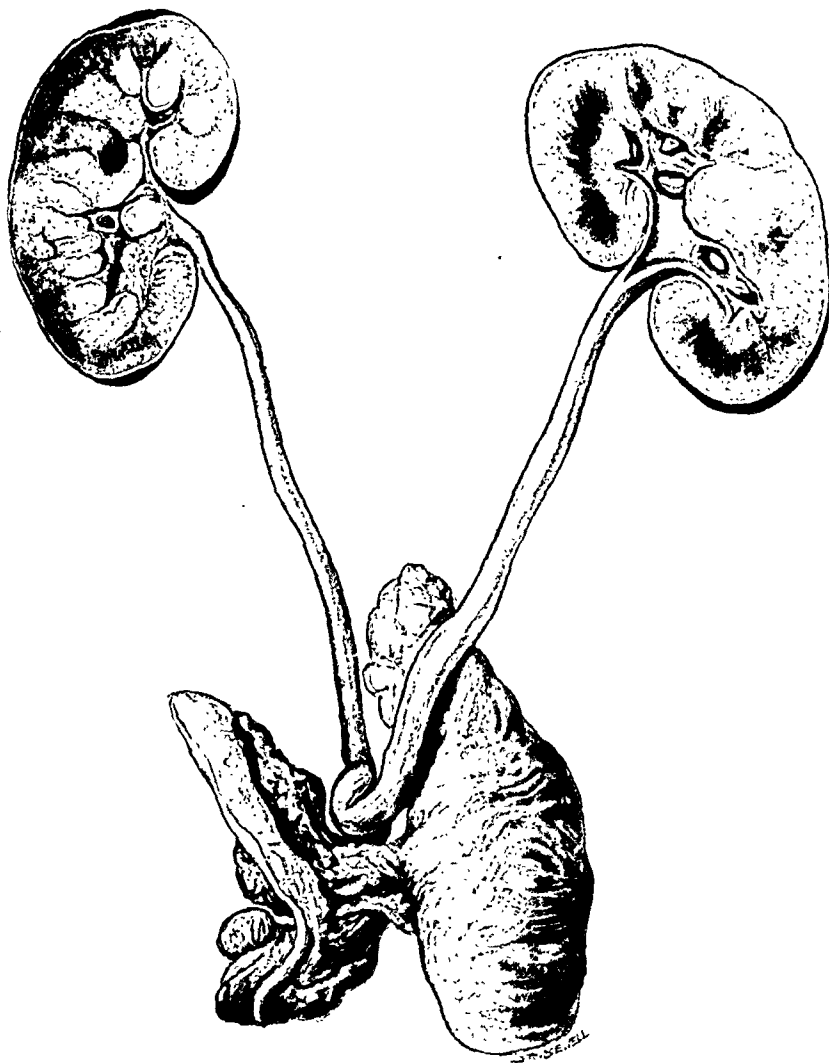
FIG. 109.—*Case* 14. J. M. Child of 1 year and 4 months. Left ureter implanted into rectum by Lendon-Peters method. Death at end of a week. The ureter had slipped out of the rectum and was lying in an abscess cavity. The corresponding kidney showed evidence of dilatation and ascending infection.

months this child did well, but it then began to suffer from prolapse of the rectum, probably the result of neglect. When seen the child was ill-nourished, peevish, and constantly crying. There was moderate prolapse of the rectum, but with a fairly good rectal sphincter. In this condition Dr. Dunlop Lickley kindly admitted the patient under his care at the Children's Hospital. The child was carefully fed and nursed, and was given seventeen doses of ultra-violet light, and had boric baths twice daily. Under this régime she steadily

improved, and in six months had gained 2 lb. 6 oz. She occasionally suffered from screaming fits, apparently associated with the descent of double inguinal herniæ. The rectal prolapse occurred only once, and that during the first week the child was in hospital. After five months' treatment the baby was transferred to the Newcastle Infirmary in very good condition.

OPERATION, May 28, 1926.—General anæsthesia. The left ureter was implanted into the rectum by the Peters method, no fixation sutures being employed. The patient stood the operation well. On May 30 the child was not well. It looked pale and ill. The temperature was 102·6°, and there was a small (?) anæsthetic burn on the chin. The latter spread rapidly, and a generalized rash appeared on the body. The condition was diagnosed as measles, and the child was sent to Isolation. The temperature remained high, 103° to 104°, and the child was very ill. The supposed burn on the face rapidly presented a condition like cancrum oris. The wound in the base of the bladder became very septic, and death took place just a week after the operation.

POST-MORTEM EXAMINATION.—General septic dermatitis, with large patch on the right cheek like cancrum oris. There was a small abscess behind the extroverted bladder, between it and the rectum on the same side as the ureter transplantation. The right ureter and kidney were normal, but the left ureter was dilated and thin-walled, and the corresponding kidney was about half as large again as the right, and was very soft and friable. The capsule stripped readily and on section the substance showed a condition of pyelonephritis. The pelvis and calices were dilated and contained some purulent urine, and there were several abscesses in the medulla.

Microscopically, this kidney showed a well-marked ascending simple infection along the tubules which had scarcely reached the cortex of the organ. The right kidney showed a well-marked parenchymatous degeneration, but no evidence of a true nephritis or of ascending infection.

The rectum and lower ends of the ureters were removed in one piece. When subsequently examined the left (transplanted) ureter was found to have slipped out of the rectum and was lying behind the bladder in the area in which the above-mentioned abscess was found (*Fig.* 109).

Case 15.—This is described as a continuation of *Case* 9.

T. L., male, age 8 years 8 months. (Reg. No. 17328.)

Case 16.—Total epispadias with incontinence. Transplantation of ureters in two stages at three weeks' interval. Acute pyelonephritis. Recovery.

J. H., male, age 3 years. (Reg. No. 18140.)

HISTORY.—The patient was a fine, healthy boy, weighing 2 st. 9½ oz., and 36½ in. in height. The urethra was open on its dorsal aspect throughout its whole length, and communicated with the bladder by an orifice which easily admitted a finger (*Fig.* 110). X rays demonstrated separation of the pubes to the extent of one inch (*Fig.* 111). When lying on the back a certain amount of urine collected in the bladder before it overflowed, but it all escaped involuntarily when the boy stood up. A No. 14 self-retaining catheter in the bladder enabled practically all the urine to be caught, and there was only a very little leakage round the tube. While in hospital awaiting operation he took his food well, and appeared to be in every way normal. An X-ray picture of the forearm and femur, made for subsequent comparison, showed well-formed, normal bones.

FIRST OPERATION, Oct. 1, 1927.—General open ether anæsthesia. Trendelenburg posture. Median incision from just above the umbilicus to just above the bladder opening. This was a trifle over 4 in. long, and, with the aid of the self-retaining retractor, gave quite a good exposure. At first the parts looked alarmingly small but this did not give rise to any real difficulty. The left ureter was selected for the first anastomosis; it was normal in size and easily identified. After incising the peritoneum over it, the ureter could be lifted from its bed and did not require any special separation. Its vessels were seen intact and were not interfered with. After dividing the ureter a spot was selected on the sigmoid convenient for the anastomosis—that is, where the necessary manipulations could be comfortably carried out. This point was a finger's length from the bottom of the pouch of Douglas, which proved by measurement to be 3 in. No clamp was used on the bowel, and the ureter was implanted by the method of Stiles, except that it was made to lie obliquely in the bowel, and not along the longitudinal band. One and a half inches of the ureter were buried. The bowel at the point where the ureter entered was fixed to the edge of the pelvic peritoneum. A small tube was brought from the region of the union and through the mid-line incision. The parietal wound was closed by figure-of-eight silk-worm sutures. The operation occupied one hour and ten minutes. A catheter was left in the rectum at the conclusion of the operation, and from this, during three succeeding periods of twenty-four hours, 8 oz., 7 oz., and 12 oz. of urine were collected.

PROGRESS.—On Oct. 4 the boy appeared to be quite well, but without warning commenced to vomit and did so copiously for some hours. He soon got over this, but it may have been a kidney reaction. He certainly got thinner for a day or two and was quieter,

FIG. 110.—*Case* 16. J. H., boy, age 3. The testicles were descended. The pubes were separated to the extent of one inch.

FIG. 111.—*Case* 16. J. H. Skiagram of pelvis.

but he gradually picked up and by the 21st he appeared to be in about the same condition as before the operation.

SECOND OPERATION, Oct. 22.—The right ureter was implanted into the bowel; general anæsthesia and technique as before. The abdominal incision was 2 in. longer. The

sigmoid was adherent to the back of the parietes. The ureter was very small, and was purposely divided obliquely. A small tube was again brought from the region of the anastomosis. This time also the operation occupied one hour and ten minutes. At the end of the operation 1 oz. of liquid contents was evacuated from the rectum. A large catheter was stitched into the rectum as before.

PROGRESS.—The child stood the operation very well, but the condition was never quite satisfactory afterwards. He vomited almost continuously, a vomit which made his lips and face sore. Nothing stayed down; thirst was inordinate, and he drank cold water copiously and continuously. By the 24th his condition gave rise to great anxiety; the vomiting continued; he looked pinched and thin; the ears were a little cyanosed; and his pulse was very quick (130–140) and of low tension. The abdomen was neither distended nor rigid. After a restless night the condition on the morning of the 25th appeared desperate, and it was decided to explore the right kidney.

THIRD OPERATION, Oct. 25.—A minimum of general open ether anæsthesia. The right kidney was easily exposed by an oblique muscle-cutting incision. There was no extraperitoneal œdema, no obvious signs of gross mischief. The kidney was a little larger than normal, but the pelvis was not dilated. The latter was opened and its mucous membrane found to be intensely engorged, but there was no escape of urine. The capsule was stripped from the kidney and the wound packed with gauze and left almost entirely open.

PROGRESS.—The condition appeared to improve at once. In the afternoon, as he was restless and had not slept since the operation on the 22nd, a dose of $\frac{1}{16}$ gr. of morphia was given. At 10.30 p.m. he was found restful, of better colour, and with a pulse of good volume. He had not vomited since 3.30. The next day, the 26th, the boy looked much better. There was a little vomiting and the abdomen was a little distended. The catheter was removed from the rectum. Large foments were applied to the right flank and abdomen. Calomel and pituitrin were given, and in the evening there was some slight action of the bowels. During the day he slept a good deal and was altogether more restful. Afterwards he steadily improved and only vomited once or twice. On the eighth day following the exposure of the kidney, there was some escape of urine from the incision for the first time.

By the end of November he was greatly improved. The mid-line incision had gaped a little and healed by granulation. Now both incisions were soundly healed. The boy was taking food again and looking well. He weighed 1 st. 11 lb. 2 oz. So far as could be ascertained there was no sign of rectal control; when he left hospital a few days later, he was wrapt in a napkin like a baby, and this was frequently wet and had to be changed. By the end of the year the mother reported that the child had been very ill since going home but was now much better: was able to be up; was walking; and had permission from the doctor to go outside. "Has nearly got control of his bowels."

REPORT ON URINE.—The urine in this case, both before and after operation, was carefully examined under the supervision of Dr. J. C. Spence, whose report follows :—

Sept. 27–28 (before Operation), Urine Collected at Intervals from a Catheter in the Bladder for Twenty-four Hours—

	Amount	Specific Gravity	Urea
2.30 p.m. to 4.30 p.m.	78 c.c.	1019	1·19 per cent
4.30 p.m. " 8.0 p.m.	46 c.c.	1015	1·81 " "
8.0 p.m. " 2.0 a.m.	105 c.c.	1022	2·31 " "
2.0 a.m. " 5.30 a.m.	105 c.c.	1014	1·62 " "
5.30 a.m. " 8.0 a.m.	170 c.c.	1006	1·35 " "
8.0 a.m. " 2.30 p.m.	180 c.c.	1015	1·31 " "

Trace of albumin; numerous red blood cells; some pus cells.

Sept. 28, Urea Concentration Test (10 grm. urea).—

	Amount	Specific Gravity	Urea
1st hour	140 c.c.	1112	1·87 per cent
2nd hour	65 c.c.	1013	3·12 " "
3rd hour	70 c.c.	1016	3·81 " "

The chief points in these results are: (1) High concentration of urine urea (3·81) after urea; and (2) No fixation of specific gravity (varying from 1006 to 1022 in twenty-four hours). These are to be regarded as evidence of good renal function.

Blood-urea.—It was found impossible to get blood for estimation on the 27th or 28th. Blood was obtained only at the first operation on Oct. 1, when the patient was under an anæsthetic; this was 78 mgrm. per 100 c.c.—higher than normal, but probably accounted for in part by the anæsthesia.

Nov. 25, after both Ureters were Transplanted.—Urine collected from the rectum contained 1·94 per cent urea. Blood-urea, 39 mgrm. per 100 c.c.

Nov. 29.—Blood-urea, 40 mgrm. per 100 c.c. The blood-urea estimations of Nov. 25 and 29 are slightly raised, and to be taken as evidence of slight impairment of renal function.

Report.—The progress of the renal function of this case should be followed by repeated blood-urea estimations. A steady rise from the present level of 39–40 mgrm. per 100 c.c. would denote progressive deterioration.

Case 17.—Ectopia vesicæ. Transplantation of one ureter.

G. M., female, age 3 years 8 months. (Reg. No. 18139.)

HISTORY.—This patient was the third child of strong, healthy, sensible parents, the other children being normal in every way. The child was fair-haired, anæmic, and delicate-looking. In addition to the ectopia the whole bladder area was herniated and the linea alba was very wide (*Figs.* 112, 113). Weight 1 st. 9 lb. 10 oz., height 33 in. The shape of the head and slight thickening about the epiphyses suggested rickets. The patient was under observation for a week and during this time took food well and appeared normal in every way. Urine was collected by ureter catheter from both kidneys. Analysis by Dr. Spence gave the following results (Dec. 13, 1927): Specimen from left ureter: Reaction, acid;
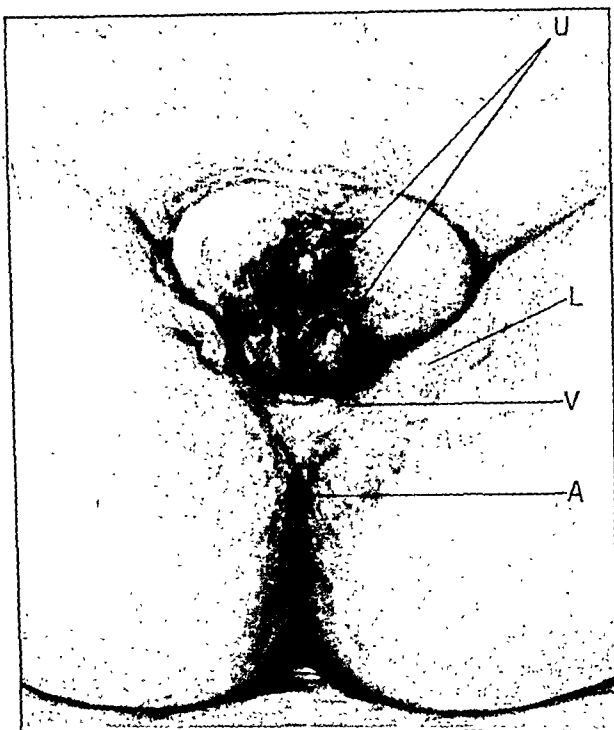
FIG. 112.—*Case* 17. G. M., a little girl 3 years and 8 months old. The parts before operation. The pubes were widely separated, but the connecting ligament was so strong that the child could be lifted from the table by a finger in the rectum. Note the excoriation of the labia and buttocks.
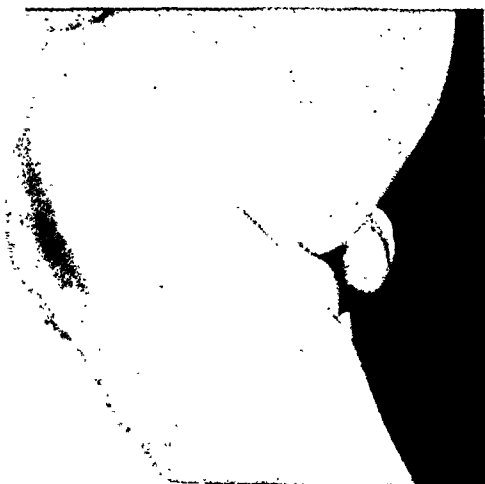
FIG. 113.—*Case* 17. G. M. To show the hernia of the bladder in profile.

albumin, present; urea, 1·5 per cent. Specimen from right ureter: Reaction, acid; albumin, present; urea, 0·5 per cent. Mr. John Brumwell also catheterized the ureters and made pyelograms of both kidneys. This examination showed both ureters were dilated, the right more than the left (*Fig.* 114).

OPERATION, Dec. 17, 1927.—Combined spinal (stovaine ½ gr., strychnine $\frac{1}{150}$ gr.) and general ether anæsthesia. The Trendelenburg posture was adopted ten minutes after administration of the spinal anæsthesia. In a few minutes respiration became very slow and sighing, and caused some anxiety. At first the abdomen was quite flaccid, and there was no tendency for the bowel to escape, but as the effects of the spinal anæsthesia wore off, prolapse of the intestine occurred, and was troublesome. This difficulty was exaggerated because the embarrassed

respiration following the spinal anæsthesia deterred the anæsthetist from using more ether. The right ureter was dilated to about four times the normal size, but the left was only half as big. The right vermiculated very vigorously on stroking. It was implanted into the sigmoid by the method of Coffey. The union seemed secure, but the method was not considered as satisfactory as the Stiles plan. The operation was more difficult than usual because of the general smallness of the parts, the fact that the ureter was almost at right angles to the bowel, and because of some anxiety about the anæsthetic. The whole proceeding occupied one hour and fifteen minutes, and the child was returned to bed in very good condition.

PROGRESS.—Recovery was quite uneventful and without any definite evidence of kidney reaction. The incision healed rather slowly and gaped a little, but the granulations were quite healthy. The child went home at the end of three weeks, and was subsequently reported to be doing well.

This child was re-admitted in May, 1928, when the second ureter was transplanted by the Stiles method. Recovery was again quite uneventful, and the patient continues to make good progress (January, 1929).

FIG. 114.—*Case* 17. G. M. Pyelogram made by Mr. John Brunwell. The dilatation of the right ureter (on the right side of the figure) was confirmed at operation.

I am very much obliged to many doctor friends who have taken so much trouble to keep me informed of the after-progress of these cases.

THE BEST AGE FOR THE OPERATION.

This depends a good deal on the size, development, and general health of the child. The earliest age at which I have personally operated by the intraperitoneal method is 3 years. At that age the parts are small and the pelvis is difficult of access, and unless for some very special reason I do not propose to operate again so early. In my view the age of election is between 5 and 7, depending on the considerations already mentioned.

EXACT TECHNIQUE OF METHOD EMPLOYED.

In some of the patients potassium citrate has been administered for a week before operating, but otherwise no special preparation has been used.

I propose to describe the operation as I have carried it out, leaving suggested modifications, etc., to be dealt with in the section devoted to ALTERNATIVE METHODS (p. 173).

There are some few anatomical peculiarities which need to be emphasized. In cases of complete ectopia the surgeon must realize that the umbilicus is merged in the apex of the ectopic bladder, and that there is always separation

of the pubes, which may be of very considerable degree—in this series from 1 in. to as much as $3\frac{1}{2}$ in. The linea alba is correspondingly wider than normal, and is represented by a strong, fibrous structure which, at its lowest part, merges with a fibrous ring surrounding the upper circumference of the ectopic bladder. In a good many of these cases the ureters are dilated, and in one of my youngest patients (*Case* 17) this was demonstrated by the method of pyelography (*see Fig.* 114), which was carried out for me by Mr. John Brumwell. Possibly the dilatation may develop subsequently in some of the cases, but it is often present as an associated part of the deformity.

The ureter is well supplied with blood-vessels, and many of them run for a considerable distance in the loose cellular tissue which forms a sort of sheath in which it lies. It is essential that as far as possible these vessels should be spared, and when the ureter is lifted from its bed, if they are not deliberately divided, they may often be preserved if the surgeon uses the method of blunt dissection or gauze stripping. In *Fig.* 89 such a vessel is seen lifted from its bed with the ureter, but remaining unharmed at the completion of the operation.

The difficulty of ensuring an aseptic field in the presence of the exposed mucous membrane is evidently more theoretical than practical, for, with the doubtful exception of *Case* 11, there has been no serious infection attributable to this source.

In most of my cases general anæsthesia, induced by A.C.E. and followed by open ether, has been employed. In younger subjects the tendency of the intestines to escape has caused embarrassment, and to avoid this it has been suggested that the patient should be put in the Trendelenburg posture before the administration of the anæsthetic. I have tried combined spinal and general anæsthesia, and it has been helpful from this point of view, but it is an anxiety in the young child, and especially where the Trendelenburg posture is employed. After all, temporary evisceration ensures the best view of the pelvis, and is not serious provided that due care is exercised in covering the exposed bowel and keeping it warm and moist.

In cases of ectopia the exposed bladder is first packed with iodoform gauze. I have always employed a vertical incision from the umbilicus where it exists, and otherwise from its position down to, but not through, the ring of dense fibrous tissue which surrounds the upper border of the exposed bladder. Once the peritoneum is opened, the intestines are packed away in the upper abdomen so as thoroughly to expose the pelvis with the sigmoid and upper rectum.

The right ureter is now always selected for the first anastomosis, because it can be most conveniently implanted into the lowest part of the selected bowel. In all cases I have easily identified the ureters, which have invariably been found lying in their normal position crossing the iliac artery. The only doubt will arise when the ureter is much dilated, but such doubt will always be set at rest by the vermicular movements of the ureter, which occur naturally at regular intervals, and which can be set up by stroking over its course with a closed artery clip, or by gently pinching the tissues in the neighbourhood with forceps.

The sigmoid is drawn up and to the left, and the site for the anastomosis is marked by a catch forceps introduced into the anterior longitudinal band. The first ureter is joined to the bowel at the lowest point which can be conveniently reached for suturing, and this in children will probably be a finger's length, say $2\frac{1}{2}$ to 3 in., from the bottom of the rectovesical pouch. In the more roomy pelvis of adults this point may be still nearer to the bottom of the pouch.

The ureter is now exposed by picking up the peritoneum which lies over it, and by incising this structure for a distance of two or three inches, depending again on whether the subject is a small child or an adult. The ureter is laid hold of with fine, mouse-tooth forceps and gently lifted from its bed of cellular tissue near the bladder; it is caught with an artery forceps as low down as possible, and divided across above the forceps. I have not found any forceps which will conveniently catch and hold the ureter sufficiently firmly to prevent slipping and at the same time without crushing, so that I now leave the lumen of the upper end unguarded, and merely take a small hold of one side of its wall with a catch forceps. The upper end of the ureter, which is to be used for the implantation, is then separated from the cellular bed in which it lies. This is easily accomplished by the aid of a dissecting forceps, or a small piece of gauze held in a clip used as in the method of gauze stripping. Only a little more of the ureter is separated than is going to be buried in the bowel wall, so that probably 2 in., or at most $2\frac{1}{2}$ in., will suffice, of course depending on the size of the subject. The large amount of ureter shown separated from its surrounding cellular tissue and elevated from its bed, in articles which have recently appeared in the medical press, is very misleading. The greatest care is taken not to divide or tear the small blood-vessels which are found passing into the ureter, for they will usually strip up and stretch sufficiently. The upper end of the ureter is thus first separated so that by turning it upwards its lumen is kinked and an escape of urine is avoided even in the absence of an occluding clip, but as an extra precaution its open end is laid in a mop of gauze. The exposed mouth of the lower end of the ureter is then carbolized, ligatured with catgut (No. 3/0 chromic), and allowed to retract into the cellular tissue towards the bladder.

A small $\frac{3}{8}$-in. incision is now made through the longitudinal band on the large bowel in the transverse direction and just above the point already marked by the catch forceps. This incision cuts through the muscular coat and exposes the mucous membrane, which is pulled up into the incision and incised just sufficiently to allow the ureter to be introduced into the lumen of the bowel without being constricted.

The upper end of the divided ureter is then trimmed obliquely, and a catgut suture (3/0 chromic gut) is passed through its pen-nib end and tied. One end of this suture is cut so as to be left 3 in. long, and this portion is coaxed with a probe into the open mouth of the ureter, so that it occupies the lumen of that portion of the tube which has been lifted from its bed. This is the catgut urine guide of Charles Mayo. These steps are illustrated in Figs. 115 and 116. The long end of the suture is then threaded on a curved needle, which is passed into the lumen of the bowel and brought out half an inch lower down. By means of this thread the ureter is drawn

into the lumen of the sigmoid; by tightening the stitch it is made to lie close up against the mucous membrane of the bowel, and is there fixed by tying the suture on the peritoneal aspect of the bowel. Usually the hole into the lumen of the sigmoid is a little too large to accommodate the ureter, and is diminished by one or two interrupted sutures so that it lies snugly round the latter.
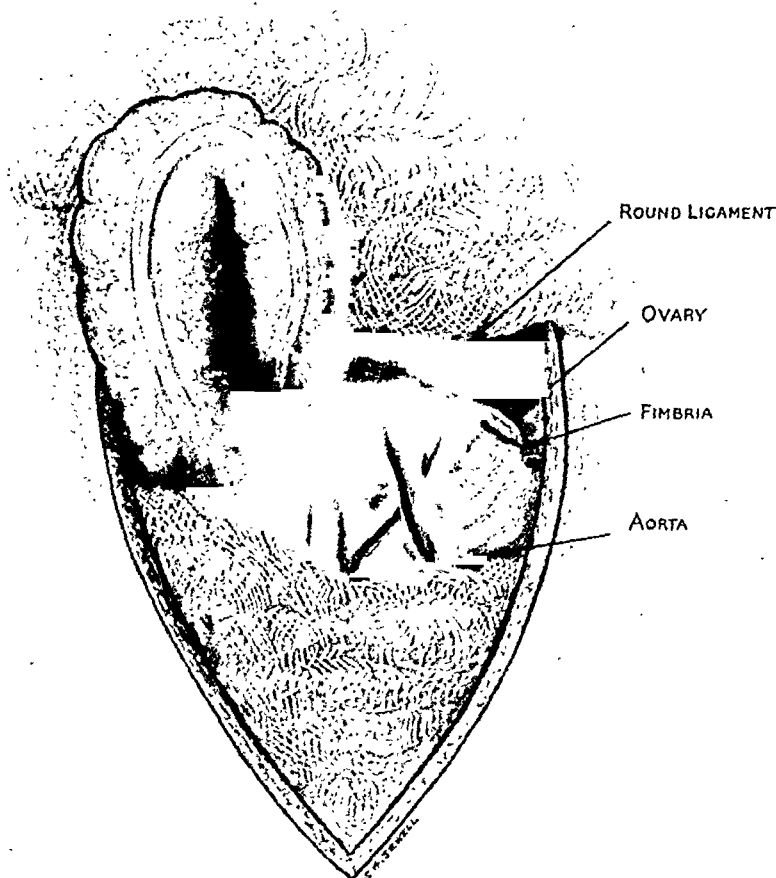
Fig. 115.—*Case 17.* G. M. The pelvic contents with ureters as exposed in the first stage of the operation. Note the dilatation of the right ureter, which was previously demonstrated by pyelography. For the sake of clearness the posterior parietal peritoneum is not shown.

The process of burying the ureter is now carried out by a series of four interrupted sutures (3/0 chromic gut) which take a good hold of the bowel on either side, but at such a distance that when drawn over the ureter the latter has ample room to lie in the groove so made without fear of causing its constriction. The amount of bowel wall required for this purpose will, of course, depend on the size of the ureter in each individual case. The first of these inverting sutures commences just above the fixation stitch, and

they are inserted $\frac{3}{8}$ in. apart. The second and third stitches just catch the outer wall of the ureter. The ureter is buried obliquely in the bowel wall so that when the anastomosis is completed it passes comfortably direct from the opening in the posterior peritoneum to the intestine without kinking. A second and final row of six sutures buries the fixation stitch and the first row of inverting sutures. Two additional sutures are passed through the outer wall of the bowel near the point where the ureter
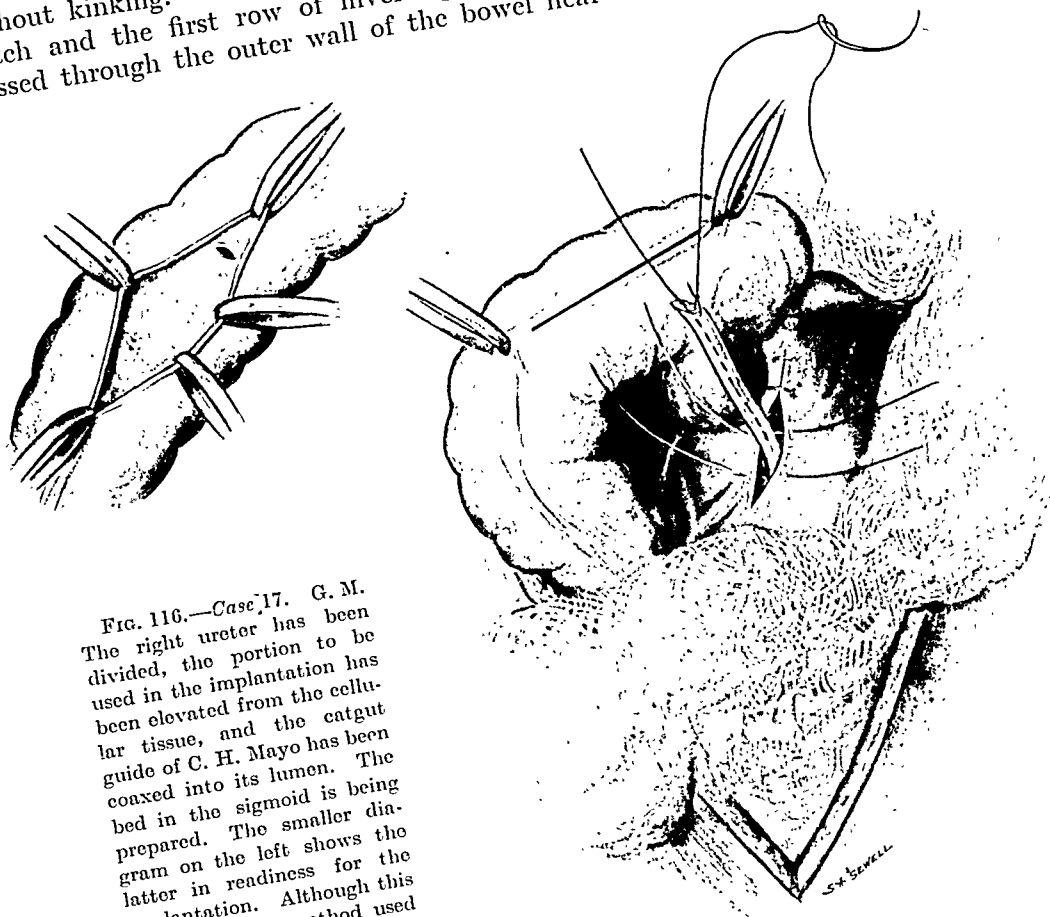
FIG. 116.—*Case* 17. G. M. The right ureter has been divided, the portion to be used in the implantation has been elevated from the cellular tissue, and the catgut guide of C. H. Mayo has been coaxed into its lumen. The bed in the sigmoid is being prepared. The smaller diagram on the left shows the latter in readiness for the implantation. Although this was the actual method used in *Case* 17, the oblique implantation shown in *Fig.* 89 has usually been used and is preferred.

enters, and are used to fix the bowel at this point to the edges of the peritoneal slit, as shown in *Fig.* 89.

When the anastomosis is completed the ureter should not be visible, for it should pass directly from its bed behind the peritoneum into the channel in the bowel. A fine rubber tube, about $\frac{1}{8}$ in. in diameter, is brought from the neighbourhood of the anastomosis either out through the lowest part of the median incision, or up behind the peritoneum to an independent opening in one or other iliac fossa, the most direct route being followed. After removing the gauze from the pelvis especial care is taken to protect the small

bowel by covering it with the omentum, and the parietal incision is closed. Whenever possible the peritoneum is sutured by a continuous stitch, but the main support for the wound is a series of figure-of-eight silkworm sutures one inch apart, and tied over rubber tubes. A few intermediate catgut stitches in the aponeurosis are valuable. Great care must be taken to close the extreme lower end of the incision, for this tends to gape, and in one case (*Case* 3) a piece of small intestine escaped and became strangulated, necessitating operative interference for its return.

At the conclusion of the operation a large rubber catheter (size 14) of the self-retaining type is left in the rectum in the hope of preventing an accumulation of urine, or urine and fæces. If it does not slip out spontaneously it is removed on the fourth day. In the cases where the bladder is exposed, the dressing of the incision must be kept separate from the dressing over the bladder; but in actual practice there has been no untoward incident due to the soiling of the incision from this cause. In examples of complete epispadias it is usually possible to introduce a self-retaining catheter into the bladder, and to draw off the urine in this way until the second ureter can be dealt with.

The operation in my hands has occupied from forty minutes to an hour, depending for the most part on the size of the pelvis. There has been very little shock, even in the youngest children. Urine commences to escape from the rectum within an hour or two, and at first, and for some few days, flows almost continuously. The bowels act without help, but sometimes a dose of calomel or castor oil has been administered if indicated.

The mild attacks of kidney infection which may come on during the immediate convalescence are usually ushered in with some pain in the affected side. On the other hand, sudden collapse or a rigor may mark the onset. The temperature soon runs up to 102° or 103°, and the pulse is correspondingly quick. The next day there is tenderness in the loin, and soon after the enlarged and tender organ may be felt. In three or four days the symptoms have usually subsided. It is surprising how little the patients seem to be upset by these attacks.

After-treatment.—No special form of after-treatment has been adopted, the patients being treated as after any ordinary laparotomy. It might help to ward off attacks of mild renal infection, and might hasten the process of stabilization, to give plain water by the bowel, and in future I am disposed to give this plan a trial.

Implantation of the Second Ureter.—This is deferred until the patient has completely recovered from the first interference. As a rule, a fortnight or three weeks suffices for this purpose. At the second operation I have always re-opened the original incision. The omentum is usually adherent to the abdominal wall, but there are only a few flimsy adhesions in the pelvis, and I have never found these obscuring the parts to
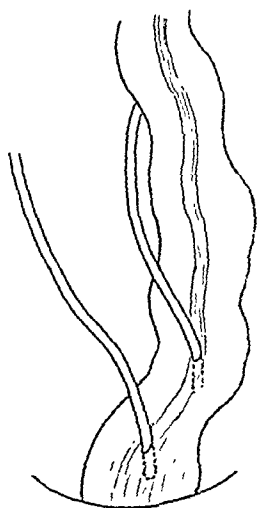
Fig. 117. — Showing the proper disposition of the transplanted ureters in relation to the bowel.

an inconvenient degree. The site of the first anastomosis is usually quite hidden, and I think it is unwise to attempt to expose it.

The second ureter is usually the left, and it is exposed as it passes over the pelvic brim, and is joined to the bowel on the inner side of the recto-sigmoid, the disposition of the two ureters being as indicated in *Fig.* 117. The details of this second stage are precisely the same as for the first operation.

REPAIR OF THE LOCAL DEFORMITY.

The repair of the local deformity is not such an easy problem as it appears. The excision of the mucous membrane of the bladder may be attended with very considerable hæmorrhage, and, even with the greatest care, in one of my cases (*Case* 3—a young adult of 19) the blood loss was enough to affect the patient very considerably. It is probably easier to excise the whole thickness of the bladder wall, but after this has been accomplished a large hole is left between the recti muscles leading into the pelvic cellular tissue, and from the depths there may be an amount of oozing which can only be controlled by the introduction of gauze packing. It sounds reasonable to talk of drawing the recti together, and covering the sutured muscles with the undercut skin from either side, but as a matter of fact the wide separation of the pubes. which is universal in cases of ectopia, renders this very difficult (*see Fig.* 104). In the one female case in which I have repaired the vulval region after excision of the bladder mucous membrane, I had very considerable difficulty in securing approximation because of the tension of the soft parts. Even after reasonable apposition had been obtained, the amount of tension was sufficient to cause some of the stitches to cut out. It is not even easy to be sure that the whole of the mucous membrane of the bladder has been removed, and in cases where this has apparently been carried out successfully, an island has sometimes remained which continues to be red and moist.

C. J. Bond[6] considers that the mucous membrane of the exposed bladder changes its character and comes to resemble the ordinary skin of the abdominal wall, and that therefore it is unnecessary to interfere for its surgical removal. On the other hand, Charles Mayo[7] and others have drawn attention to cases in which epithelioma has developed on the exposed mucous membrane, and they have used this as an argument in favour of its removal. In my experience I have seen neither of these developments, but I think that, on general grounds, it adds to the comfort of the patient if the external, and obvious, deformity is repaired as far as possible. In some cases in which the ectopia falls short of completeness, it may be possible, even in the male, so far to close the anterior aspect of the ·bladder and the urethra as to make the patient appear more or less normal. In these lesser degrees of deformity the problem is not so difficult, as there is not such wide separation of the pubes. In complete epispadias the gap between the bladder and the dorsal surface of the urethra can be readily covered in and the parts restored wonderfully satisfactorily. In *Case* 8 (*Fig.* 96), by such intervention the copulative and procreative faculties appear as if they would be abundantly restored.

Among the many alternative methods suggested for dealing with ectopia, I still remain attracted by the plan suggested by Trendelenburg of dividing the sacro-iliac joints with the idea of securing approximation of the pubic bones so that the bladder may be pushed back into position and be secured by suture of its anterior margins. This manœuvre might be helpful after successful transplantation of the ureters, as one of the steps towards the more complete repair of the deformity associated with the ectopia itself.

OPERATIVE MORTALITY AND COMPLICATIONS.

In this series of 17 cases it will be seen that there have been 4 deaths directly due to the operation, a mortality of 23·5 per cent. Since most of the cases have been dealt with in two stages there have been 28 separate operations, making the mortality 14·3 per cent. It we take the number of times the separate ureters have been transplanted, we have 29, with 4 deaths, equal to a mortality of 13·8 per cent. The Mayos, in a series of 60 cases, had a mortality of 13·33 per cent.

In my own series the cause of death in three of the cases was peritonitis. In the first patient (*Case* 4) this resulted from sloughing of the ureter, with pelvic peritonitis. There was also an acute ascending pyelonephritis. In that case both ureters were transplanted at one sitting. In the next death (*Case* 6) the peritonitis was due to a direct leak from the second ureter. The latter was much dilated and the last fixation stitch had entered its lumen. The third death (*Case* 11) was also the result of peritonitis, following the first ureter transplant. In this case the anastomosis was intact, and the pathologist was inclined to think that the infection had arisen in the neighbourhood of the abdominal incision.

The fourth death occurred in *Case* 14, a baby of 1 year and 4 months. One ureter only was transplanted, by the Lendon-Peters method, and the child died of a general septic dermatitis with cancrum oris. Post mortem an abscess was disclosed behind the bladder, and the end of the ureter was found to have escaped from the rectum. This retraction of the ureter had evidently occurred some time after the anastomosis, because the ureter was found dilated and the kidney enlarged and infected.

Most operators have noticed that the fatalities have occurred either when both ureters have been transplanted at one sitting, or after the transplantation of the second ureter in the divided operation. In a case operated upon by a colleague, which he very kindly allows me to mention, the child of 4 died on the tenth day following the anastomosis of the second ureter. During the days which elapsed after the operation the child vomited continuously and rapidly wasted. At the post-mortem a septic peritonitis was found, most marked in the pelvis, where there was much purulent fluid and lymph. The ureter last transplanted was markedly dilated as far as the pelvic brim, at which point it had sloughed and given way. The part of the ureter between the pelvic brim and the bladder was much thickened, and intensely black on its mucous surface (*Fig.* 118). The corresponding kidney was enlarged, and showed gross evidences of infection spreading into the substance from its distended and infected pelvis. Recovery after transplantation of the first ureter to be dealt

with in this case had been without incident.   At the post-mortem the anasto-
mosis looked sound and the kidney was apparently unaffected.   A more
critical examination showed that this ureter was completely obstructed in its
passage through the bowel, and it is questionable whether the anastomosis
had ever functioned.   Quite probably the absence of the customary reaction
on that side had failed to protect the opposite kidney from the severe inflam-
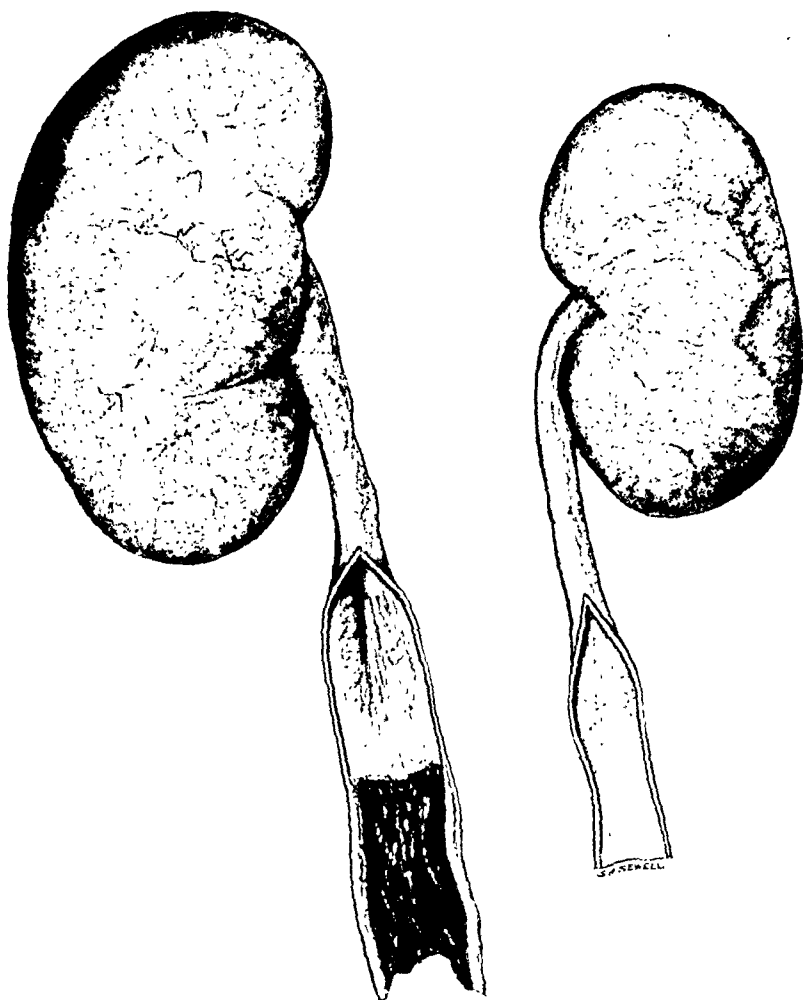
FIG. 118.—Gangrene of the ureter as found post mortem 7 days after transplanta-
tion into the bowel.   The corresponding kidney is enlarged and was infected.

matory troubles which followed the second operation.   It is in guarding
against a sequence of this sort that the catgut urine guide of Charles Mayo
is so valuable.
      The reiteration of the causes of death in my cases goes to show the
wisdom of the prophylactic operative measures which have now been incor-
porated in the routine operation—namely, the two-stage operation, the catgut
urine guide, and the drain tube from the site of anastomosis.

GENERAL HEALTH OF THE RECOVERED CASES.

A perusal of the case records will show that the general health of the ten surviving patients is not far removed from normal, as judged by ordinary standards rather than clinical laboratory tests.

It takes time for the system to become accustomed to the altered state, and it is a question of months or even as long as two years before the condition of the patient can be said to have become stabilized. In the intervening period they are acquiring complete rectal toleration and the kidneys are presumably accommodating themselves to the element of constant mild infection. It may also be that there is continuous absorption of urine from the bowel,
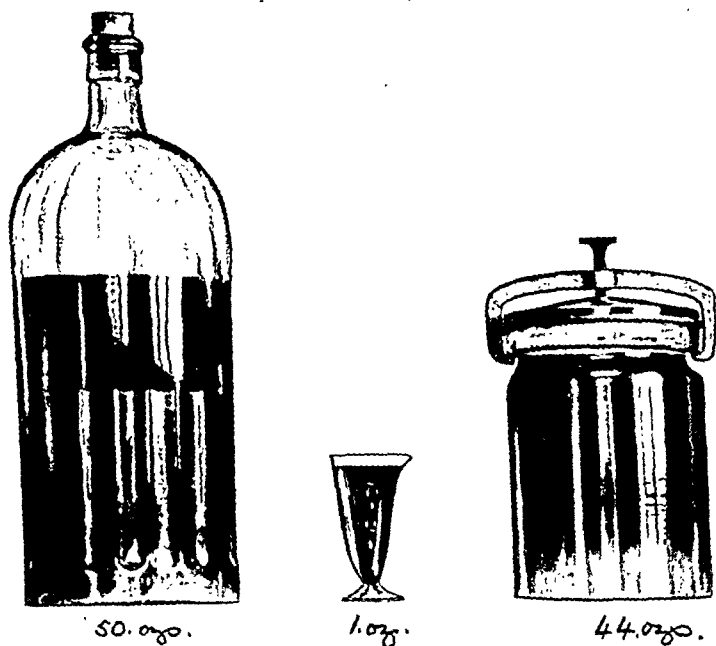
Fig. 119.—Case 9, T. H., a boy age 4 years, after implantation of the ureters into the bowel. To represent graphically the horrible discomfort and distress that must attend total incontinence of urine. The Winchester quart contains the normal daily secretion, and the 44 oz. in the specimen jar is the amount passed per rectum in this case after successful transplantation of both ureters.

and this may have some effect on the general nutrition and well-being. Whatever the cause, the records of the cases show that the condition in the first two years is not so satisfactory as afterwards. This is important from a practical point of view, and I think that during this period it is wiser not to attempt any such operative interference as may be desirable for the removal of the bladder mucous membrane or other plastic procedures. Fortunately during this period of stabilization the patients are not ill in the sense of being laid up, and in fact the new-found blessing of continence (*Fig.* 119) buoys them up so much that they can afford not to be depressed about any little physical weakness that may be present. They sleep and eat well and are ordinarily

active, but they keep thin, or even get thinner, and may be anæmic and seedy. When stabilization is complete they fill out, gain colour, and increase in strength and happiness. The change is often very striking, and has usually been a matter for remark by their friends. Eventually they get so well that they are able to do just as others of their age. Thus children attend school and enjoy games with their playmates, while older patients are able to work and to assume the responsibilities and duties befitting their station.

Judged by the standard of weight and its relationship to height and age, many of the patients are below normal; but the fact must not be overlooked that in almost every case, before the operation they were smaller and less developed than children of their own age. This particularly applies to Cases 1, 7, 12, 13, and 17, who could only be looked upon as delicate children, and unsuited for any but the most necessary operation.

TABLE SHOWING RELATION OF AGE, WEIGHT, AND HEIGHT
(CORRECTED FOR SEX).

Case	Age	URETER TRANSPLANTS				NORMAL			
		Height		Weight		Height		Weight	
		ft.	in.	st.	lb.	ft.	in.	st	lb.
2	36	5	1½	7	2	5	1	8	9
3	29	5	10	10	7	5	7¾	10	12
1	24	5	4½	7	9	5	7¾	10	8
8*	19	5	4½	8	9	5	7¼	9	13½
5	16	5	0	8	9	5	1¾	8	1
7	14	4	2¾	4	2¾	4	11¼	6	8
12	13	4	4¾	3	12½	4	9	5	12½

* Only one ureter transplanted.

The original development of the children seems to have more to do with the ultimate result, so far as general health and strength is concerned, than anything associated with the actual operation. For instance, Case 3, who was not operated upon until he had attained the age of 19 years, was a big, strong lad at that time. Convalescence was interrupted by intestinal obstruction, and he was submitted to a plastic operation during the early weeks following the transplants, yet he has developed still further and is able to carry out the ordinary duties of a farm worker. Case 5 was very ill after the second transplant, either as the result of some sloughing of the ureter or perinephritis, but in spite of this she has grown big and strong, and is more robust than any of the other patients. Case 10 did very well and enjoyed really excellent health until overtaken by an attack of intestinal obstruction, and yet at the post-mortem one of the kidneys showed gross dilatation and evidence of infection. The case of T. L., Case 9 and 15, is also illustrative, for he has apparently only one functionally active kidney, and that with a greatly distended ureter and liable to attacks of infection, and yet his general health and development appear to be little affected. Case 2, who married

since the operation, has become the proud mother of two healthy children, and is now, thirteen years later, wonderfully well and leading a life of great activity.

RECTAL TOLERATION.

Rectal toleration does not develop at once, but the time required for the lower bowel to become accustomed, not only to the presence of urine, but to the unwonted amount of fluid contents, is very variable. As might be expected, the younger the subject, the less the control at first, yet all but the youngest patients have learnt to ask for the bed-pan before the time of leaving hospital. After the second stage of the operation toleration at night comes remarkably quickly and, except in the early stages, 'wet beds' are uncommon. Immediately after the operations, and for the first day or two, the urine seems to run away constantly from the anus, so much so that I often do not think it necessary to persist in keeping a catheter in the bowel, for the presence of such a foreign body in the anus is greatly resented.

When once toleration has been acquired it is very wonderful, for most of the patients can hold urine for several hours during the day, and nearly all night, without any discomfort. In the cases in which this could be ascertained, the average time was 3 hours. The longest was $4\frac{1}{2}$ hours. All the patients state that though they have the desire to evacuate the rectum three or four times each day, they can contain the urine a good deal longer if circumstances demand it. Most of the patients get up once by night, and sometimes twice or even thrice. As a rule they waken without trouble, but Case 3, who has always had some incontinence by night, states that he empties the rectum quite involuntarily during sleep, and is not conscious that he has done so. On the other hand, Case 12 passes urine three or four times every night, but sometimes when very tired he does not get up to use the chamber, and a wet bed results.

The quality of the urine seems to have more to do with the toleration of the rectum than the quantity. When patients are suffering from 'renal attacks' and have presumably highly infected urine, they have great frequency, or even incontinence, though at ordinary times these same patients may have perfect toleration. When the patients are quite well the capacity of the bowel may be tremendous. For instance, on one occasion Case 1 held his urine as long as possible—i.e., from 9 a.m. to 1.15 p.m.—and then evacuated no less than 29 oz., which looks a formidable quantity in a Winchester quart ! At one o'clock this boy had a meal, and just before he commenced to eat he said he felt anxious to empty the bowel ; but the desire soon passed off, and he was able to wait in comfort until he had finished eating. Another patient (Case 3) held his urine as long as possible, and then voided 18 oz. The general health, quite apart from the question of renal infection, seems to have something to do with this question of toleration.

RECTAL FUNCTION AND CONTROL.

Usual amount voided at a time	5 oz.
Amount which can be comfortably retained	10 oz.
Maximum amount passed at any one time	29 oz.

Out of 10 cases, 7 have perfect control both day and night, and 3 have some incontinence at night only.

The problem of where the urine is actually stored in the bowel is of great interest. It cannot be in the rectum, for this part of the bowel is quite unable anatomically to contain the quantity of fluid which sometimes collects. In some of the cases submitted to sigmoidoscope examination, interesting information has been obtained on this point. On passing the instrument just within the sphincter, a small amount of urine escapes—2 to 3 oz.; but on advancing the instrument to examine the upper rectum, or lower sigmoid, a further and much larger quantity comes away; and as the higher reaches of the bowel are explored, still further amounts are evacuated. Post-mortem specimens showing enlargement and distension of the colon suggest that the whole of the large bowel may act as the reservoir. In *Case* 13, who was operated upon for the repair of the local defect two years and three months after the transplantation, the nurse who administered water per rectum was alarmed at the amount which easily flowed into the bowel by gravity. Unfortunately no accurate measurement was made, as the importance and interest of the point were not then realized, but she did observe that there was well over two pints. This boy unfortunately died, and his rectum and whole colon were filled, though not distended, with formalin solution in the preparation of the specimen, and for this purpose 1120 c.c. (39½ oz.) of the fluid were used. In *Case* 10, who also died, these observations were not made, but the colon was certainly more than usually capacious.

I have no facts to prove whether or not the fluid contents of the colon in these cases is absorbed, as has been assumed, but that is a matter which merits inquiry.

The anal sphincter, as tested by the finger, I have always found to be competent and alert, and that was so even in the case of a boy (*Case* 9) who was alleged to have loss of control, and who certainly had some slight anal prolapse at times. That the sphincter is more than usually active is proved by the fact that when these patients are placed under full anæsthesia the anus does not allow any escape of the rectal contents, and yet the passage of a catheter or the sigmoidoscope into the rectum demonstrates the presence of an ounce or two of fluid contents. When the latter instrument is used under anæsthesia and is passed a few times, the anus may become patulous; but in the absence of anæsthesia it remains on guard, and, from the story of the patients, without any effort so far as they are concerned.

Four of the patients state that they can pass flatus independently of evacuation, but nearly all the others expressed their inability to do so.

Sigmoidoscopic examination has been carried out both with and without anæsthesia. No special preparation has been used, and in every case, except for liquid contents, the bowel has been found empty of fæces and quite clean and healthy-looking. The mucous membrane is invariably moist and looks oily, but is otherwise normal. It does not seem to be unduly sensitive, and is capable of considerable air distension. The gradual filling of the instrument with liquid, and the constant steaming of the eyepiece by the warm urine, are new and interesting experiences. The search for the orifices of the ureters has not always been successful. Eight sigmoidoscopic examinations were made in seven patients, and one or both ureters were found in only four. In one patient (*Case* 5) both ureters were seen on one occasion soon after she had

recovered from an attack of renal infection, and the corresponding ureteric orifice was found pouting and bright red in colour. On another occasion, two or three years later, a painstaking examination entirely failed to discover either orifice !

In the post-mortem specimens which are available, two types of ureteric opening are demonstrated (*Fig. 120*). In the one the opening is funnel-shaped and is hidden beneath a fold of mucous membrane. In this type the area

FIG. 120.—*Case 13.* W. B. The recto-sigmoid, showing the entrance of the ureters in detail. The right is a small orifice not much larger than the bristle which is thrust through it, and is hidden under a fold. The corresponding kidney was dilated (*see Fig. 106*). The left ureteric orifice lies above a shelf in the bowel, and is like a rosette. It easily admitted a probe of $\frac{1}{8}$ in. diameter.

from which urine has trickled or suffused has been seen, but there is no definite spurt to indicate the actual orifice. The other type, represented by a sort of rosette, can be clearly seen and functions characteristically. As seen in the coloured drawings (*Figs. 92 and 102*), carefully made by Mr. Sewell from his own observation, these openings are on the summit of what looks like a polypus (*Case 12*), or more a cow's udder or the uvula (*Case 3*). When quiescent these excrescences hang flaccid, and are of a colour slightly pinker

than the surrounding mucous membrane ; but when about to discharge urine they are seen to vermiculate. and then to retract, the extremity becomes irregular and pouts, and urine is discharged in a small spurt.   In *Case* 3 the urine came from the side of such a uvula-like process. near its base, and not from the extremity.   The discharge of urine appeared to be at about the normal rate and quantity, but I am not sure that this is necessarily an evidence of a normal ureter.   In *Case* 9 the ureter. which had previously been implanted into the rectum by the Lendon-Peters method, was subsequently exposed on the floor of the ectopic bladder as the result of accidental injury during a plastic operation, and was seen to eject *clear* urine in spurts, but. on introducing a ureteral catheter. a quantity of *pus* was evacuated.   At a subsequent operation. when this ureter was implanted into the bowel, it was found to be dilated almost to the size of the small intestine.   So far as an isolated observation goes, this suggests that a dilated ureter may vermiculate and evacuate its contents at the normal rate.   The intramuscular injection of indigo-carmine has not helped in the identification of ureteric orifices otherwise elusive.   In *Case* 3, in which the ureteric uvula was first found. the blue effluent appeared at the normal time—seven minutes—and identified the site of the orifice very beautifully (*see Fig.* 92).   The orifices which have been seen have usually been found just at the point at which the internal iliac artery causes a prominence in the bowel, and by measurement this was found to be about 8 in. from the anus.

The character of the evacuations is interesting.   As a rule fæces and urine are intimately mixed. making up an offensive puddle with an indescribable odour.   At other times the patient may void a soft, pultaceous stool, and sometimes, though rarely, a solid evacuation.   At still other times the same patients will get rid of clear urine which has a decidedly offensive odour and contains an excess of mucus.   On one occasion (*Case* 12) the patient, in the course of a three-hour morning. passed first 3 oz. of thick, pultaceous fæces, then 1 oz. of quite liquid mixed fæces and urine. and lastly $7\frac{1}{2}$ oz. of turbid urine which deposited about 25 per cent of fæcal matter.   Some of the patients always pass mixed fæces and urine. while others habitually void clear urine at one time and the mixed fæcal puddle at another.

None of the patients have complained of untoward irritation of the rectum, and the sigmoidoscope has not demonstrated the presence of proctitis, though this was found in a mild degree at the post-mortem in the two patients (*Cases* 10 and 13) who were confined to bed for some days before death. Possibly the excess of mucus which is always present exercises a protective action on the bowel wall.   The rectum from *Case* 10. the boy who died from intestinal obstruction 3 years and 3 months after the ureter transplant, does show some thickening of all the coats, and the mucous membrane is covered with an inflammatory exudate (*see Fig.* 97).   It must be remembered that this patient was very ill and confined to bed for a week before the specimen was taken.

At one time the patient W. K. (*Case* 3) was so much troubled with nocturnal incontinence that he always slept in a puddle.   During this period the skin round the anus was sodden and whitened, resembling the skin of the abdominal wall around a suprapubic urinary opening.

WIDENING OF THE PELVIS.

Widening of the whole pelvis which results from the separation of the pubes is quite a striking feature which must not be overlooked (*see Figs*. 101 and 111).

A good many of these patients walk with a tendency to waddle, suggesting the gait of patients suffering from congenital dislocation of the hip. In one or two of the patients this has caused anxiety to the parents, but I have not known any complaints from the patients themselves, and they certainly appear to get sufficiently strong to enable them to carry out practically anything, just as normal children or individuals, and certainly this condition seems to be less noticeable and to give rise to less trouble as they grow older.

THE RENAL FUNCTION.

Judged by the standard of the general health, it may be said that none of the patients in this series shows definite evidence of gross renal insufficiency.

At the outset I must say I feel convinced that most of these patients develop some degree of ascending renal infection. This is borne out by the fact that in the two cases in which it has been possible to make post-mortem investigations there has been definite and gross evidence of its existence, in spite of the fact that during life neither of these patients suffered from symptoms indicating its presence.

Among the ten cases that are alive and well, and on which I have definite information on this point, there are three patients (*Cases* 8, 12, and 17) who, at 7 years, 3 years and 3 months, and 8 months after operation, have never suffered from any symptoms indicating renal infection. In *Case* 8 only one ureter has been transplanted.

Cases 1 and 2 have suffered from slight attacks of pain in one or other kidney region, with lassitude, possibly temperature, and frequent micturition, but these symptoms have never caused serious inconvenience.

Case 3 has suffered three or four times from a very definite kidney infection, and in one attack he was very ill with a high temperature (105°) and a tender left kidney.

Case 5 is the patient who, during her immediate convalescence, developed a perinephric abscess on the right side. In spite of this she has developed into a big, strong, robust girl, but she has on four or five occasions suffered from a recrudescence of infection, although in the intervals she has remained perfectly well. Since the Hunterian Lecture was delivered this girl has had another attack, and X rays show what is almost certainly a renal calculus on the right side.

Case 7, during immediate convalescence, suffered from intraperitoneal infection which probably originated about the site of the anastomosis, and though he has developed very well and is in very good health, he has at least twice suffered from febrile attacks of renal origin as shown by tenderness over the kidney regions.

Cases 9 and 15 refer to the same patient. This is the boy with one functional kidney with a greatly dilated ureter. After the intraperitoneal transplantation he had a smart attack of infection of the left kidney, and

three months later this was followed by a severe attack, ushered in by rigor and vomiting. His general health is good, and development is proceeding normally.

Case 10 was in remarkably good health until his death, which was due to peritonitis following an operation for intestinal obstruction. The peritonitis was the result of leaks in connection with an intestinal anastomosis. At the post-mortem examination both kidneys were found dilated, there was evidence of infection, and microscopically both interstitial and epithelial changes were found.

Case 12 probably suffered from some renal infection after the transplantation of the first ureter, but he made an entirely uninterrupted recovery after the second operation, and has exhibited no signs of renal infection since.

Case 13 was also particularly interesting, because he never showed clinical evidence of gross renal infection, but, on his death, which occurred two years and three months after transplantation, both kidneys showed marked evidence of ascending infection.

From these clinical observations it would appear that a moderate degree of renal infection is not inconsistent with average good health and well-being. It is to be remarked that, not only are these patients in good average health, but they stand up well to the trials of their ordinary environment. As the case records show, several of them successfully underwent operations under general anæsthesia without untoward symptoms. Further, Case 2 was not more than ordinarily upset by child-bearing and lactation. The fact that both the patients who died after operations subsequent to the transplantations (Cases 10 and 13) showed acute renal infection superadded to the gross and long-standing changes is not, in my opinion, any evidence that these patients were suffering in that way before their fatal illness. Mechanical drainage does much to minimize the effects of a chronic renal infection, and the fact that these patients were bedridden would in itself tend to allow the infection to run riot. Further, the acute exacerbation was probably more of the nature of a terminal outburst.

Chemical examination has only been carried out in a few cases, and the results, so far as they have been obtained, are set out in the following table :—

THE RENAL FUNCTION.

CASE	PERIOD SINCE OPERATION	PERCENTAGE OF UREA IN EVACUATION	BLOOD-UREA MGRM. PER 100 C.C.	AGE–WEIGHT–HEIGHT RATIO	GENERAL HEALTH
1	14 years	0·62	52	Below normal	Very good
2	13 ,,	1·5	27	,, ,,	,, ,,
3	10 ,,	1·5	34	Normal	,, ,,
5	5 ,,	0·6	—	Below normal	,, ,,
7	7 ,,	0·5	21	,, ,,	,, ,,
8*	6 ,,	0·5	36	,, ,,	,, ,,
9	4 ,,	1·3	—	,, ,,	,, ,,
12	3 ,,	0·37	—	,, ,,	Rather thin and weakly
13	2 ,,	1·62	—		

* Only one ureter transplanted.

Most of the patients are abnormally thirsty and drink copiously of water, and they state that the quantity evacuated per rectum bears a definite ratio to the intake. In three cases the total amount passed per rectum has been measured. V. K. (*Case* 5) passed 33 oz. in twenty-four hours. This was three years after the operation had been completed, and she was then 9 years and 8 months old. *Case* 9, a boy of 4 years of age, passed 44 oz. in twenty-four hours (*see Fig.* 119), and *Case* 10, a boy 10½ years of age, seventeen days after operation, passed only 25 oz. in the twenty-four hours. It is quite likely that more urine is passed as the renal organs become more accustomed to their altered condition.

ALTERNATIVE METHODS.

In this series of cases, with two exceptions, I have adopted the plan of intraperitoneal implantation of the ureter, largely based on the technique of Sir Harold Stiles. The Peters operation, or rather the Lendon-Peters operation, appeals to one because of its simplicity, and I believe it might have been attended by more success if it had been the rule to transplant the ureters by this method in two stages. But it is a method in which the operator has no opportunity of controlling the exact site of the anastomosis, and it can only be carried out in males. There are several cases on record in which the ureter has slipped out of the bowel, and in which, in consequence, an obstruction has formed which has interfered either with the immediate success of the operation, or with the subsequent utility of the anastomosis. This accident occurred in one of my cases (*Case* 14), and *Fig.* 109 illustrates exactly what was found post mortem. There are methods by which such an accident might be prevented, and these have sometimes been adopted, such as fixing the ureter by a stitch to the rectal wall, or fixing it by means of a catheter inserted into its lumen. Personally I much prefer the intra-abdominal method, which is under the guidance of the eye and can be more directly controlled in all its details. Of course, when available, the Lendon-Peters method can be employed in very young children, and should it prove a failure for any reason the intraperitoneal method can still be carried out at a later stage if the patient survives.

The most important recent contribution to this subject has been made by Robert C. Coffey, of Portland, Oregon, U.S.A., who has devoted very considerable attention to the transplantation of the ureters, and I am much indebted to him for keeping me informed of the progress of his work. In a series of recent papers he has drawn attention to improvements in the methods which have hitherto been employed. He first devised the plan of making the implanted ureters lie for a considerable distance in a submucous bed (*Fig.* 121), in the hope that the ureter would be compressed and temporarily closed by the pressure inside the bowel, thus preventing regurgitation of the bowel contents into the ureter itself (*Figs.* 122 and 123).

The next step consisted in the employment of ureteric catheters, which were tied into the ends of the ureters and were passed into the bowel, so that for ten days or thereabouts the secretion from the kidneys could be assured of a free passage without the temporary obstruction which sometimes arises as the result of œdema about the anastomosis.

The final problem which Coffey set himself to solve was the prevention of infection from the bowel lumen, and his latest technique (which has been described[8] since the delivery of the Hunterian Lecture) includes a method by which he attempts to sterilize the lower segment of the bowel before the
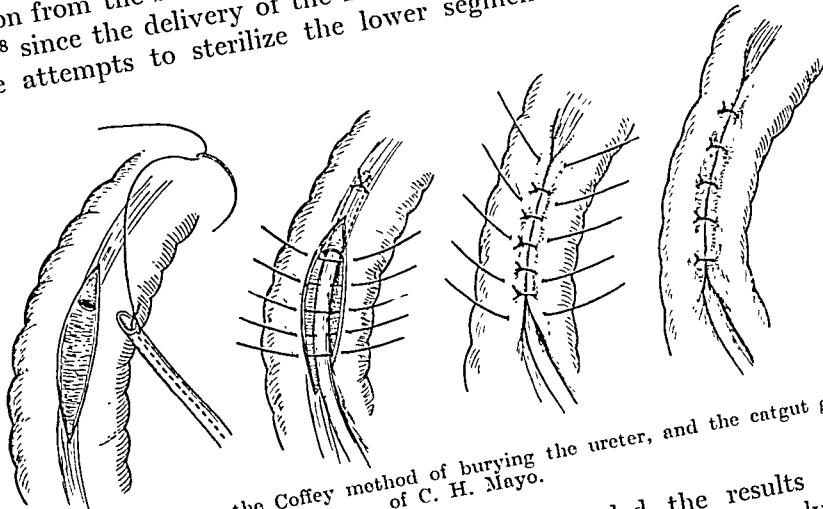
FIG. 121.—Shows the Coffey method of burying the ureter, and the catgut guide of C. H. Mayo.

implantation is carried out. Coffey has recorded the results of 9 cases operated upon by his completed technique. One patient was only 20 months old at the time of double implantation of the ureters for ectopia. This operation was carried out a year before publication, and the patient was in good health and without evidence of renal infection. The other 8 cases operated upon appeared to be equally satisfactory. His important papers should be carefully perused by anyone interested in this particular problem.
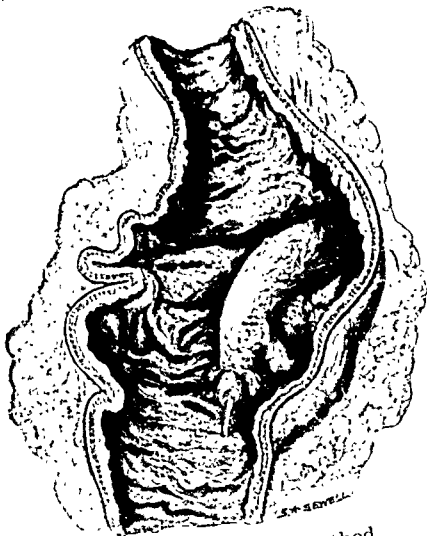
FIG. 122.—Coffey method.
Showing the result of operations carried out on the fresh cadaver. In both cases a fine wire has been passed through the ureter to demonstrate its orifice in the bowel.

FIG. 123.—Stiles method.

Coffey's results have been so encouraging that, if extended experience in the hands of other operators bears out the work of the originator, then I have no doubt this operation will become the method of choice. In my

experience some degree of infection has occurred sooner or later, and I shall be surprised if any procedure can be devised which can prevent its advent in all cases. The catgut guide of Charles Mayo is probably an advantage, but on the other hand it may be that the submucous position of the ureter recommended by Coffey makes it much less likely to be obstructed in the earlier days.

Most workers have assumed that infection has been directly conveyed to the ureter by regurgitation of the bowel contents, but I believe that this is wanting in proof. In *Case* 13 it was not possible to make any fluid pass up the ureters from the bowel when this experiment was tried with the fresh parts just after death. In fact, in order to distend the ureters sufficiently for the purpose of setting up the specimen, it was necessary to pass a hollow needle into each separately. Yet in this boy both kidneys showed evidence of gross ascending infection. Possibly the infection reaches the ureters and kidneys by means of the ascending mucous currents described by C. J. Bond.[9] In my view it is essential to have an unimpeded opening into the bowel, and anything like obstruction, not even amounting to stricture, is more likely to bear a causal relationship to infection than any other factor. This view would bring it into line with other infections secondary to disease in the lower urinary passages.

THE SEXUAL PROBLEM.

At the outset I stated that the importance of the sexual problems associated with these deformities had early been brought before my notice. At that time it never occurred to me that the grosser forms of anomaly could be sufficiently rectified to restore the sexual functions, and it was with the idea of arresting development of the testicles that I excised portions of the vasa in my first three cases. At that time I was not aware that John Hunter had shown that division of the vas was not followed by atrophy of the testicle, and I am much obliged to Sir Cuthbert Wallace for pointing this out to me. The normal development of the patients whom I treated in this way has certainly shown that the sexual characteristics are not appreciably altered, but as yet I have no means of knowing whether their procreative functions have been arrested.

The general development and well-being of the patients here recorded encourages me to believe that reconstructive operations on the external genital organs may enable the victims to follow the dictation of their natural instincts. With the female patients there seems no barrier either to marriage or maternity, and the wide pelvis and separated symphysis render delivery easy.

AFTER-HISTORY OF SOME OTHER CASES NOT PREVIOUSLY PUBLISHED, AND FROM THE LITERATURE.

Through the kindness of Emeritus Professor Sir Harold Stiles, I am able to publish the after-history of some of his cases of transplantation of the ureters. I have further to thank Professor D. P. Wilkie, who kindly arranged to have the cases traced. This work was carried out by Mr. W. C. Wilson, of the Department of Surgery in the University of Edinburgh, to whom I am greatly indebted for the trouble he has taken on my behalf.

Case 1.—C. D., female. Epispadias. Operation in 1907 at age of 3. Reported well in 1913. At present (January, 1928) aged 23 years, unmarried; in constant employment as a dressmaker. General health excellent. Can retain for five or six hours during the day. Rises once at night to micturate. Very rarely some loss of control and slight escape of urine. Somewhat sensitive disposition.

Case 2.—A. McK., female. Epispadias. Right ureter transplanted. Operation in 1908, at age of 7. Perfect recovery. Seen 5¾ years later. No evidence of renal infection. Perfect control over urine, which she can retain for five to eight hours. Slight proctitis. Very well March, 1914, six years after operation. Not traced since.

Case 3.—R. G., male. Extroversion of bladder. Transplantation of both ureters into pelvic colon. November, 1911, at age of 3. The child made an excellent recovery from operation. The boy died on June 22, 1927, at the age of 19 years. Control of urine seems to have been entirely satisfactory, and apparently there was no complaint referable to the operation. He never showed any signs of puberty. The voice did not break, and at death he was only 3 ft. 6 in. in height. In appearance and development he was as a child of 7 or 8 years. The case-notes state that both testicles were descended. For years before death he suffered from periodic attacks of ' cyclic vomiting'. Death occurred in one of these attacks. The terminal illness was apparently marked by convulsions, and according to the doctor it was a very typical attack of cyclic vomiting.

Case 4.—E. S., female. Epispadias. Operation in 1913 at age of 3. At present (January, 1928) aged 18 years ; unmarried. Employed as cakebaker. Condition does not interfere with employment. General health has been uniformly good since operation, and is at present excellent. Can retain urine for five to six hours. Sometimes suffers from lack of control during the night ; otherwise perfect control. Is contemplating marriage.

Case 5.—A. S., female. Extroversion of bladder. Right ureter transplanted into the pelvic colon, June, 1919. Left ureter November, 1919, at age of 5. Made excellent recovery from both operations. For some three or four years afterwards there was occasional leak-age of urine from the bowel by day and every three or four hours at night. Could retain urine for a maximum period of five hours. During these years occasional attacks of mild general systemic disturbance with pain in left kidney region and diminished urinary excre-tion. For the past five years condition has gradually improved—now about one in a year. Now, the attacks of pain, etc., have become much less frequent—now about one in a year. Now, January, 1928, nearly nine years after operation, is of slight build and sensitive disposition. General health excellent. Occasional slight lack of control. Passes urine (with fæces) every two hours by day and rises once during the night. Can retain urine for five hours fairly easily.

Case 6.—J. N., male. Epispadias. Age 7 at time of operation. Previous to this had undergone numerous operations on neck of bladder with no success in establishing any control. Right ureter transplanted January, 1920 (technique modified in that opening of ureter was enlarged by longitudinal incision). Ureter came adrift from bowel about a week later. At further operation (April 24) ureter could not be brought down to pelvic colon, and a fistula was made to anterior abdominal wall. To relieve this condition the right kidney was removed on Oct. 25. Further operation not advised. Patient brought back four years later and earnest request made for operation, since life with incontinence was proving unbearable. Left ureter transplanted May 16, 1924 (by Coffey method). No urine passed after operation. Died in uræmic convulsion on May 21.

Mr. Robert Purves, of Lincoln, operated upon a case by the method of Stiles, and he has very kindly sent me the following notes together with the after-history.

J. W. L., male, age 31, was admitted to the County Hospital, Lincoln, on Oct. 22, 1922, for ectopia vesicæ and epispadias. The patient stated that he had always passed urine through the abdominal wall, and that, being continually wet, he had suffered very much from excoriation of the skin, which had rendered him less and less able to get about, so that he had been confined to his bed for the past twelve years.

His condition on admission to hospital was that of a frail, anæmic man. There was marked pyorrhœa, and much deformity from his prolonged residence in bed in a faulty attitude. The left hip was flexed 120°, externally rotated and abducted. The knee of the same side was flexed 100°. The right hip was also flexed to a like extent, internally rotated and adducted, and the corresponding knee was flexed to a slightly less extent. The whole spine was curved antero-posteriorly. and also to the left, the costal margin

touching the iliac crest. Both abdominal recti muscles ᵃ .. ⋅ ⋅ ⋅ .. ⋅⋅⋅⋅ contracted. He had a well-marked ectopia vesicæ with complete ⋅; ⋅⋅ ⋅. I ⋅.. surrounding the bladder and that of the groins was much excoriated, with marked proliferation of the epithelium. This skin and the mucous membrane of the bladder were very sensitive. X rays showed failure of fusion of the pubic arch. The testicles were normally descended, and there were no signs of any other congenital deformity, while he was said to be sexually fully developed.

It was decided to treat the condition by transplantation of the ureters after the method of Stiles, and on Oct. 24, 1922, he was put on a mixture containing urotropine and acid sodium phosphate, by way of preparation. Two days later the right ureter was transplanted into the pelvic colon through a right rectus incision. The patient passed urine per rectum the morning after the operation. Four days later, on Oct. 30, he was given a pill of methylene blue, and the colour was well exhibited in the motions. Urine was passed per rectum at two-hourly intervals during the day, and every four hours during the night. A few days later he was able to go as long as four hours during the day, and during the night he was only disturbed twice. In another week the day period had increased to five hours.

On Nov. 15, twenty days after the first operation, the left ureter was transplanted. There was considerable difficulty in approach owing to the contracted condition of the left rectus. The right ureterocolic anastomosis was found to be sound, and no adhesions were encountered. Five days later the patient was passing urine per rectum four-hourly during the day, and a fortnight later he was able to hold his urine in the rectum as long as four and a half hours, but he had some incontinence.

All his teeth were extracted three weeks after the second operation, and on Feb. 14, 1923, he was discharged from the hospital. He had good control of the urine, but there was much moisture from the exposed mucous membrane of the bladder. As this moisture was coloured blue after the exhibition of methylene blue, the presence of a third ureter suggested itself.

Three and a half months later, on May 28, the patient returned to hospital for treatment of the ectopia and epispadias. He occasionally had some urine passing through the bladder, but was dry for more than a week at a time. Urine was being passed per rectum three-hourly. Three days later, on May 31, the posterior wall of the bladder was freed all round except for a pedicle below. The mucous membrane of the floor of the urethral furrow was divided from the skin margin of the penis, and the bladder wall was turned down and sutured to the edges of the urethral mucous membrane so as to form a roof to the urethra. The skin edges of the abdominal and penile wounds were then united each to each. Six days later the patient passed some urine through the new urethra. The abdominal wound had given way a little at the upper extremity, but was granulating well, and he was discharged on June 21. He refused to have any treatment for the correction of the deformities of the legs, but their positions were somewhat improved from those present on his first admission.

Two years later Mr. Purves visited this man at his home. He had complete control of the rectum, with evacuation every four to four and a half hours, and had then been dry for twelve months. He was getting about well with crutches, and frequently rode several miles on a bicycle. He had started work as a boot repairer. Though still very pale, he was fatter and much healthier-looking than before.

NOTE.—Dr. E. Barry Denny reported that J. W. L. died of pneumonia on Nov. 21, 1925, after six days' illness. No evidence of renal infection was observed then or previously. There was no post-mortem examination.

Through the kindness of Mr. Lawford Knaggs I am able to append the following note on the subsequent history of an adult female, whose case was fully and most carefully recorded by him[10] under the following title : " On Implantation of the Ureters into the Rectum by the Sacral Route, Illustrated by a Case of Inveterate Vesico-vaginal Fistula in which the Left Ureter was Implanted and the Right Kidney Removed ".

The patient, 42 years of age, was admitted to the Leeds General Infirmary in February, 1909. Five years previously, during a difficult confinement, she was so much torn that the bladder and vagina were converted into a single compartment. For the cure of her miserable condition she had submitted to thirteen operations before she came under the care of Mr. Knaggs.

This surgeon gave very careful consideration to the case, and finally worked out a plan for implantation of the ureters by the sacral route. On account of the extraordinary amount of scar tissue only one ureter could be dealt with as intended, and subsequently the

opposite kidney was removed. Eventually the patient made a complete recovery and went to her own home. Seven months later she reported herself as very well and able to retain urine for about three hours. Sometimes at night there was a little incontinence if she happened to sleep unusually soundly. Three years later she was again in hospital for the treatment of a prolapse of the exposed mucous membrane of the bladder through the vesico-vaginal fistula. This was corrected by plastic operations. In October, 1927—that is, eighteen years after the implantation of the ureter—she reported herself as very well, with no pain or bad effects from the operations, and able to work well looking after her own house. At no time have there been any symptoms suggesting infection of the kidney.

In 1909 Sir Arthur Ball,[11] of Dublin, recorded the case of a boy 5 years of age, the victim of ectopia vesicæ, upon whom he had operated in July, 1908. The ureters were implanted into the rectum by the Lendon-Peters method, and subsequently the mucous membrane of the bladder was removed. Sir Arthur very kindly traced this patient for me, and he reports that now, twenty years after the operation, he is still well and strong, with good rectal control, and able to earn his own living.

The following statistics have been extracted from one of the latest papers on the subject from the Mayo Clinic.[5] I have often discussed the matters under consideration with Dr. Charles Mayo, and I am much obliged to him for several personal communications, and especially for his kindness in drawing my attention to the value of the catgut urine guide.

MAYO CLINIC STATISTICS.

From 1901 to April 1, 1926 :—
71 Cases operated upon—
       Plastic operations only   ..   ..   ..   8 cases
       Transplantation of both ureters   46   ,,
       Transplantation of one ureter..   10   ,,
       Exploration only   2   ,,
       Moynihan's operation   2   ,,
       Coffey's operation   3   ,,
11 Deaths from operation (16·6 per cent)—
       5 from peritonitis, 4 from septic kidney, 2 from
          renal insufficiency.
7 Late deaths,
       2 months to 12 years after operation. Only 1
          due to renal complication.
29 Ureter transplants reported as to after-results—
       25 satisfactory, 2 poor control, 1 has incontinence.
       These patients are alive and well from 1 to 15 years
          after operation.

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SHORT NOTES OF RARE OR OBSCURE CASES

A CASE OF HÆMATURIA ARISING FROM ONE SEGMENT OF A DOUBLE KIDNEY, TREATED BY RESECTION.

By ARTHUR JACOBS,

SURGEON TO OUT-PATIENT DEPARTMENT AND UROLOGIST, GLASGOW ROYAL INFIRMARY,

THE following case appears to be worth recording :—

Miss B., a woman, age 40, was admitted to Glasgow Royal Infirmary with a history of continuous hæmaturia of five months' duration. The bleeding was unaccompanied by pain, colic, or other urologic symptoms, and the general examination was negative. The urine was deeply blood-stained, contained no casts, and was sterile. On cystoscopy two ureteric orifices were observed on the left side, situated on a common ureteral ridge. The efflux from the outer and higher orifice was deeply blood-stained, whereas that from the inner and lower one and also that from the right ureteric orifice were clear. An estimation of the renal function by the indigo-carmine test revealed no impairment, a strong blue efflux appearing at the three ureteric orifices within four minutes of intravenous injection.

Subsequently the three ureters were catheterized, and a pyelographic examination was carried out : the right pelvis was first distended with the opaque fluid, and immediately thereafter the two pelves on the left side were filled.

FIG. 124.—Bilateral pyelogram. The upper and inner pelvis on the left side is nearly empty. The lower and outer one is normal in appearance. On the right side the pelvis is of the bifid type.

After taking the pyelogram (*Fig.* 124) it was found that the upper and inner left pelvis had almost evacuated its contents ; this was therefore distended once more, and another X-ray photograph taken (*Fig.* 125). It will be seen that the two pelves on the left side are completely separated from one another and occupy different levels. The superior and inner one

is the smaller, and practically consists of two calices ; the lower and outer pelvis is normal in appearance ; that on the right side is of the bifid type. The examination thus showed that a complete reduplication of the pelvis and ureter existed on the left side, and that the source of the hæmaturia was confined to the lower portion of that kidney, although the cause of the hæmaturia was not made apparent. As no spontaneous diminution in the bleeding was observed, it was decided to resect the affected portion.

OPERATION.—The kidney was exposed and delivered through a curved lumbar incision. A shallow groove was observed in the kidney proper, passing from the lower part of the hilum in front to the convex border just below its mid-point. The groove was not continued on to the posterior surface. The resection was commenced by ligating and dividing the vessels running to the lower part of the kidney. The lower segment was then separated from the upper by an incision which was made to pass through the groove mentioned above. The outer ureter was next divided, and the lower segment removed. There was surprisingly little hæmorrhage from the cut surface of the upper segment, and it was readily controlled by deep mattress sutures, which were passed through the kidney substance. A rubber-tube drain was placed below the cut surface of the kidney and brought out through the upper angle of the incision, which was then closed.

AFTER-HISTORY.—The hæmaturia disappeared within twenty-four hours of the operation. Some considerable leakage of urine took place through the tube during the four days that it was allowed to

FIG. 125.—Skiagram taken after the upper and inner pelvis had been refilled.

remain in position, and after removal of the tube this continued through the opening which had been left at the upper end of the wound. The rest of the wound healed by first intention. The patient was sent to the convalescent home three weeks after operation, by which time the leakage had almost ceased. She returned to hospital two weeks later, however, with a profuse urinary discharge. This was again confined to the original drainage opening, the rest of the wound having remained intact. The patient was re-admitted, confined to bed, and put on urinary antiseptics. The discharge ceased and the fistula closed in ten days. An indigo-carmine functional examination was then carried out, and within four minutes of intravenous injection a strong blue was observed coming from the left inner ureteric orifice and also from the right one. There was no recurrence of the hæmaturia.

PATHOLOGICAL FINDINGS.—For the following account of the findings in the resected portion of the kidney (*Fig.* 126) I am indebted to Dr. Helen Wingate.

Ward Specimen No. 1914. *Lower Half of Left Kidney.*—On splitting the portion of kidney removed, a small area of hæmorrhage is evident at the apex of one of the calices, and its appearance suggests the presence of an angioma. Microscopic examination, however, proves it to be an interstitial hæmorrhage, associated with a considerable round-celled infiltration. The renal parenchyma shows early chronic changes. These are well-marked in the glomeruli, some of which are swollen and adherent to Bowman's capsule, while others

FIG. 126.—Photograph of the resected portion of the left kidney. The arrows point to the area of hæmorrhage, which is immediately adjacent to a calix. The macroscopic appearance suggested a hæmangioma.

show commencing fibrosis, and a few are comparatively fibrous. In many cases Bowman's capsule is thickened, and in some cases hyaline. The tubular epithelium shows intense cloudy swelling and some catarrh. The renal vessels are unduly thick.

Comment.—Chronic nephritis may be present without there being any clinical evidence of that condition. Probably in many cases it is the underlying cause of so-called 'idiopathic or essential hæmaturia', and should be suspected in a case of hæmaturia if no other cause for the bleeding can be ascertained after a complete urologic investigation. Long-continued hæmorrhage may necessitate nephrectomy to save the patient's life. In this case, as the result of the pre-operative investigation locating the source of the hæmaturia to one segment of a double kidney, it was possible to plan a conservative operation and to remove only the offending portion of the organ.

CONGENITAL DIVERTICULUM OF THE STOMACH IN AN INFANT.

By NEIL SINCLAIR.

SURGEON TO THE EVELINA HOSPITAL FOR CHILDREN, LONDON.

THE following case seems worthy of record :—

In May, 1928, a male infant, age 4 months, was admitted to the Evelina Hospital with symptoms suggesting intussusception—that is, vomiting and the passage of blood by rectum. For five weeks the child had attended the out-patient department for wasting and constipation. The vomiting and passage of blood had been present for only a few hours before admission; the vomit from time to time contained bright blood in small quantities. The child's general condition was poor, and considerable wasting was present. A small rounded tumour was felt in the left upper abdomen and was also palpable by a finger in the rectum.

At operation performed the same day no intussusception was found, but from the region of the duodenojejunal flexure protruded a globular tumour, a little larger than a golf ball (*Fig.* 127). This was plum-coloured and tense, and had a short but well-defined pedicle which passed above the duodenojejunal flexure and was attached intimately to the under-surface of the transverse mesocolon just above the flexure. Its surface was covered by a thin
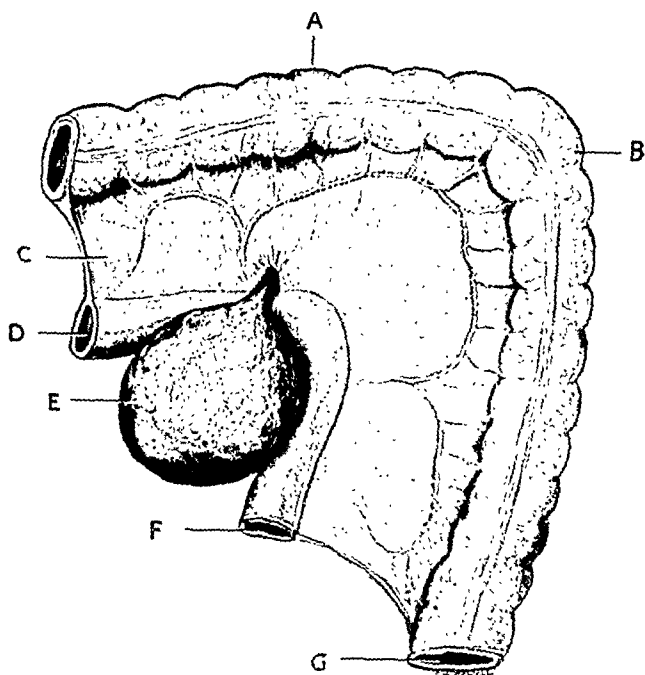
FIG. 127.—Relations of tumour as found at operation. A, Transverse colon thrown back; B, Splenic flexure; C, Transverse mesocolon; D, Duodenum; E, Tumour; F, Jejunum; G, Descending colon.

vascular film of peritoneum apparently derived from the mesocolon. The pedicle did not appear to be attached to the colon, duodenum, pancreas, or stomach, all of which were carefully examined. The tumour was opened : its wall was thick and deeply congested and its cavity contained dark blood and mucus. A thick rugose mucosa was present. The pedicle, though not apparently twisted itself, was very intimately connected with the mesocolon, which seemed to be constricting it. Owing to the poor condition of the child it was not deemed advisable to trace the pedicle

further by dissection; it was accordingly divided and the stump oversewn. No lumen was visible while this was being done. The colon, duodenum, pancreas, and stomach were all again examined and appeared normal. Operation shock was severe, but the child made an uninterrupted recovery, and was, some eight months later, well and strong.

Naked-eye examination of the tumour afterwards showed a globular sac with well-developed muscular coat and a thick mucosa resembling that of the stomach. Opposite the pedicle on the inner side was a depression from which a fine probe passed easily into the pedicle. Further examination of the pedicle confirmed the impression formed at operation that no twisting had occurred.

A month after operation the child was given a barium feed and the stomach was X-rayed by Dr. Henderson, Radiologist at the Evelina Hospital; the radiographs show an apparently normal stomach.

Microscopic sections made of the wall of the tumour by Dr. Elworthy, Pathologist to the West London Hospital, and by Mr. T. P. Lawrence, of the Royal College of Surgeons Museum, show that its structure is identical with that of normal stomach (*Fig.* 128). Oxyntic cells are present. The specimen is preserved in the Museum of the Royal College of Surgeons.

I am indebted to Sir Arthur Keith for the following remarks on the condition :—

Fig. 128.—Microscopic section of tumour. A, Mucous membrane; B, Muscularis mucosæ; C, Submucous layer; D, Transverse muscle with fibrous tissue; E, Subperitoneal tissue.

" 1. As to the nature of the cyst there can be no doubt; it reproduces the exact structure of the stomach and therefore one infers it arose from that organ.

" 2. There was no food in the cyst, therefore its lumen had no open communication with that of the stomach.

" 3. A diverticulum arising from the dorsal border of the stomach, during the second month of development would be included in the dorsal

mesogastrium, where it would lie near or beside the pancreas, and when the omental sac is developed would come to be in the posterior wall of that sac. I infer that the cyst described here has arisen thus.

" It is clear that the circulation of the cyst became obstructed in some way and a state of threatened gangrene set in. The symptoms of obstruction were apparently of reflex origin ; when the cyst was removed they disappeared. I have not come across such a specimen as this before, but I know records of such have been made—although they are rare."

CONCLUSIONS.

1. The specimen appears to be one of true congenital diverticulum of the stomach. It was not possible at operation or by subsequent X-ray examination to determine its exact site of attachment to the stomach.

2. The symptoms which led to operation were presumably due to an increasing constriction of the pedicle by the transverse mesocolon through which the diverticulum had passed (or around which the mesocolon had developed).

3. There was no evidence of torsion of the pedicle.

A CASE OF OSTEOMYELITIS OF THE SPINOUS PROCESS OF A DORSAL VERTEBRA.

By S. J. HARTFALL AND L. B. HESELTINE,

THE GENERAL INFIRMARY, LEEDS.

THE case reported is one of considerable interest, illustrating the difficulties of diagnosis in a condition of acknowledged rarity yet of gross pathology as revealed at autopsy.

HISTORY.—The patient, a boy, age 8 years, was admitted to the Leeds General Infirmary with the following history. He was quite well until three days before admission, when, shortly after bathing in the sea, he complained of a dull pain in the middle of the back, and vomited bilious material. Both symptoms continued for two days, and on the third day a doctor was consulted. He diagnosed '? meningitis' and advised admission to hospital.

ON ADMISSION.—On the day of admission the vomiting ceased and did not recur. The child's temperature was 101°, pulse 132, respirations 36. He lay perfectly still and looked acutely ill. His mental condition was quite normal; he answered questions intelligently and promptly. The face was flushed a little and somewhat expressionless. There was no headache, squint, or ocular disturbance of any sort, but there was notable rigidity about the neck, and Kernig's and Brudzinski's signs were positive. No sensory changes were present, tendon reflexes were normal, and the plantar reflex was flexor. The only other obtrusive feature was the intense hyperæsthesia which seemed to extend over the whole length of the spine and was maximal in the lower

dorsal and lumbar regions. The skin and subcutaneous tissues in this situation appeared normal.

A lumbar puncture was performed; the fluid was under slightly increased pressure and of a faint turbidity. Cytological examination showed slight excess of cells, which were polymorphs. No growth was obtained on culture. A radiograph of the spine was negative.

SUBSEQUENT COURSE.—The child's condition grew steadily worse; there was a persistent remittent and intermittent temperature, opisthotonos, and spinal hyperæsthesia so extreme that he could not bear to have his back touched, and cried out if the cot were jarred.

A second lumbar puncture was attempted; only a few drops of yellowish fluid were obtained, however, again with excess of polymorphs. Further attempts at lumbar puncture were made, but never was fluid obtained.

On the seventh day of the illness the temperature stood at 103° and the child became delirious for the first time; the back arched almost to a semicircle. Towards night it became obvious that the patient would not survive many hours. He died early in the morning, the temperature rising to 107°.

POST-MORTEM FINDINGS.—On incising the muscles on either side of the spinous processes in the dorsal and upper lumbar region, thick yellow pus escaped in considerable quantities. It appeared to be occupying the fascial spaces between the various muscles composing the posterior spinal group, and seemed to originate from the region of the 6th dorsal spine. Further dissection revealed this process and its laminæ stripped bare of periosteum and having a dead white appearance, in marked contrast to the processes above and below it. The tip, on its lower edge, was eroded and the bone here was soft, and crumbled on scraping with a knife. By pressure pus could be made to exude from the spinal canal through the interlaminar membrane (ligamentum subflavum) above and below the affected vertebra.

On removal of the spinous processes by sawing through the laminæ, the spinal dura was found to be firmly attached to their inner aspects and was congested, rough, and perforated at one or two points, while the ventral portion of the dura was free, entirely unattached, and not obviously inflamed. Thick yellow pus was found to occupy the whole length of the spinal canal from bulb to cauda equina. The bodies of the vertebræ were healthy. The brain and membranes appeared normal and there was nothing of interest elsewhere. Films of the pus showed numerous staphylococci, and on culture a pure growth of *Staphylococcus aureus* was obtained.

We are indebted to Dr. W. Vining for permission to publish this case.

REVIEWS AND NOTICES OF BOOKS.

The Art of Surgery : A Text-book for Students and Practitioners. By H. S. SOUTTAR, D.M., M.Ch. (Oxon.), F.R.C.S. (Eng.), Surgeon to the London Hospital.   Crown 4to. Pp. 624 + viii, with many illustrations, some in colour. 1929. London : William Heinemann (Medical Books) Ltd. 30s. net.

WHETHER surgery is an art or a craft is a debatable point. Perhaps the truth is that, as in many other vocations, it is a combination of the two that produces the ideal. Add to the perfected skill of the craftsman the imagination and breadth of view of the artist and we have a man capable of steering the ship of knowledge into unexplored waters and of charting the way so that others may follow.

Mr. Souttar's *Art of Surgery* strikes us as the work of a craftsman rather than of an artist. He has set out to lighten the burden of the student by omitting what is not essential and describing very fully what is fundamental. We can hardly say that in this he has entirely achieved his object, for he has tended in places to give details at the expense of fundamentals. There are thirteen pages on cerebral tumours alone, while the whole of cerebral and head injuries is dispensed with in a matter of ten pages.

The system of marginal illustrations by line drawings has much in its favour, as it avoids breaking up the text and diverting the reader's attention. The majority of these drawings are self-explanatory, but some, we feel sure, will convey but little to the student, and those on hernia he will find perplexing. The four marginal sketches on page 245 have puzzled us in endeavouring to interpret them. The section on diseases and injuries of nerves is excellent and the drawings are good, but surely a detailed account of the injection of the Gasserian ganglion for trigeminal neuralgia is superfluous.

There are a number of references to comparatively rare conditions, such as the gravitation paraplegia of Thorburn and Mikulicz's disease, while there is no mention of spinal shock or mixed parotid tumour. In a book of this nature the author is bound to be dogmatic, so that the practising surgeon may not find himself in agreement with all the statements made ; but to the student just beginning the study of a subject, dogmatism is infinitely preferable to a confused mass of theories, the truth or otherwise of which he has no opportunity of testing. However, few will agree with Mr. Souttar when he says that in the absence of a palpable tumour the case is probably not one of intussusception ; that diaphysectomy in osteomyelitis is often necessary ; or that the operative treatment of congenital dislocation of hip is seldom successful. The section on the abdomen is simple and well balanced ; but we would impress on the student that fæcal vomiting is rather a sign of impending death than of intestinal obstruction.

We have the impression that Mr. Souttar has aimed at originality and uniqueness, and we congratulate him on his success in this ; but we think that Billroth's description of tuberculous granulation tissue as being like ' ivy on a wall ' is preferable to the author's ' lichen on a stone '.

The student will find the book pleasant and easy to read, and he will be the better for its perusal, covering as it does the main facts of the subject. We cannot say that it will supplant his usual text-books, but he will find it a useful introduction to the subject.

Surgery in the Tropics. By Sir FRANK POWELL CONNOR, D.S.O., F.R.C.S., D.T.M. and H., Lieut.-Col. I.M.S., Professor of Surgery, Medical College of Bengal, Calcutta, and Surgeon to the College Hospital. Post 8vo. Pp. 293 + ix, with 99 illustrations. 1929. London : J. & A. Churchill. 12s. 6d. net.

SURGERY in the tropics necessitates a knowledge not only of those surgical diseases and their complications which are rare elsewhere, but also of the modifications which general surgical methods must necessarily undergo to adapt themselves to the peculiar features of tropical environment. It is to the former that the author has almost entirely devoted this book of 300 pages, although he foreshadows the possibility of a future opportunity of directing attention to the latter. He points out that the steadily increasing use of aerial transport, with its rapidity of travel, is likely greatly to extend the area in which 'tropical' diseases will be encountered in the future ; it will then be necessary for all medical students to receive instruction therein. The author is to be congratulated on having been able to describe so many tropical diseases within his restricted space, though doubtless opinions will vary as to whether the best possible apportionment has been obtained. The important subject of plague is very summarily dismissed, whereas an excellent account is given of liver abscess and its treatment, stress being laid on the great change of outlook that has resulted from the introduction of emetine.

Errors are very few, though on page 88 'ileo-sigmoidoscopy' should read 'ileo-sigmoidostomy'. This book should be studied by all those who intend to practise in tropical regions.

Neurosurgery : Principles, Practice, and Treatment. By WILLIAM SHARPE, M.D., Professor of Neurosurgery, New York Polyclinic Hospital and Post-graduate Medical School, etc. ; and NORMAN SHARPE, M.D., Attending Neurosurgeon, St. Mark's Hospital and Hospital for the Ruptured and Crippled. Medium 8vo. Pp. 762 + xxxvii, with 208 illustrations in black-and-white, and 5 in colours. 1928. London : J. B. Lippincott Co. 42s. net.

THE presentation of a large volume devoted to the problems of neurosurgery testifies eloquently to the growing importance and complexity of this particular specialty. Within these lavishly illustrated pages the authors deal with the theory and practice of the surgery of the brain, the spinal cord, and the peripheral and cranial nerves ; the surgery of the sympathetic system is not considered. It must be confessed, however, that this presentation of neurosurgery falls very short of the ideal, and despite its length, cannot be considered as an exhaustive—or even adequate—monograph. Clinical and pathological details of brain tumours are treated very sketchily, though the authors give a useful discussion on the so-called 'pseudo-tumour' or 'wet-brain'. The chapters on cranial injuries are good, and the value of spinal manometry is emphasized as an early indication for operation. " Chronic brain injuries " are well discussed, and it is shown that two-thirds of a series of patients discharged from hospital with the diagnosis of fractured skull in the decade 1900–10 subsequently showed persistent cerebral disturbance. Brain trauma in infancy is next discussed, but its importance in the etiology of Little's disease is probably exaggerated. The chapters on spinal tumours are good, and it is interesting to note that the dangers of lipiodol as a routine diagnostic aid are stressed. But when we read that " no unfavourable case-reports have been found in the literature " we are shown merely the inadequacy of the authors' search. There is some confusion of thought expressed in the paragraphs on the chemistry of the spinal fluid, especially where it is stated that in regard to albumin " its presence in the normal fluid has been disputed by some ; at any rate it is present only in minute quantity."

Most British surgeons and neurologists—while agreeing with the authors in their praise of resection of the sensory root of the Gasserian ganglion for trigeminal neuralgia—will profoundly disagree with their condemnation of alcoholic injection into the ganglion as a therapeutic measure. Nor will they subscribe to the authors' operation of peripheral neurectomy for trigeminal neuralgia localized to one division. Treatment of general paralysis by the intraventricular injection of salvarsanized serum is described, and details are given of the authors' experimental work with the introduction of dyes into the cerebrospinal circulation of animals. The most

extraordinary and indefensible point of all, however, is that the authors advocate laminectomy as a deliberate form of treatment in cases of disseminated sclerosis. To argue that marked improvement has followed such measures means nothing to those with experience of this disease. No reference is made in this book to the operation of chordotomy or to the treatment of intractable pain and gastric crises by spinal ramisection.

Ulcères de l'Estomac et du Duodénum. By VICTOR PAUCHET, GABRIEL LUQUET, and A. HIRCHBERG. Crown 4to. Pp. 354, with 309 illustrations. 1929. Paris: Gaston Doin et Cie. 13s. 9d.

VICTOR PAUCHET has the gift of exposition and commands the services of an artist whose pen technique is extraordinarily striking in its beauty and effectiveness. The usual arrangement of a work such as this has been reversed, in that the operative details and clinical management of patients are considered first, this part being written in association with Luquet, the pathology and etiological considerations being left for Part II. This is rather unfortunate because it is apt to magnify the place of surgery in the treatment of gastric ulcer, whereas all thinking clinicians are coming to look upon surgery, essential as it is, as only a necessary temporary phase in the evolution of medicine. Starting from this basis the surgeon is free to lay down rules for the conduct of cases where medicine now fails. M. Pauchet is dogmatic but logical in his recommendations. He states that only one method of suppressing hyperchlorhydria is known—namely, a large pylorogastrectomy—and he sees in this fact the only pointer to effective treatment of ulcers of the stomach or duodenum associated with excess of acid. He declares himself for this reason a partisan of resection à outrance in ulcer. Rightly he says it is no argument against resection that the operation is difficult. He disposes of the mortality argument by comparing his own mortality of 4·9 per cent for gastrectomy with that of hysterectomy for myoma, which is the same and is not usually considered a very serious procedure.

Gastrojejunostomy, Balfour's operation, annular gastrectomy have all been found unsatisfactory in his hands. Whenever possible he performs pylorogastrectomy for ulcer of the duodenum when accompanied by hyperchlorhydria, and always for gastric ulcer from fear of cancer supervening. For duodenal ulcer with low acid content he performs a simple gastrojejunostomy. The descriptions of difficult gastrectomy and duodenectomy operations are admirably clear. To get free access, he seems prone to make an L-shaped incision of the abdominal wall without hesitation.

With regard to post-operative hæmorrhage as a complication of gastric surgery, the interesting statement is made that if gastric lavage and a blood transfusion do not suffice to stop it, any attempt at re-opening the abdomen and active hæmostasis is doomed to failure. The author says that in such circumstances there is nothing to do but stand by and watch the patient die.

In the section on the treatment of hæmorrhage from the ulcer itself the logical course is recommended of operating to remove the ulcer as soon as and whenever the condition of the patient will allow. But it is not easy to understand quite how this decision is to be made. Pauchet brings forward again his view that very severe and fatal poisoning from the absorption of the products of digestion of the patient's own blood takes place, so that after removal of the ulcer it is necessary to wash out the contents of the colon, for which a cæcostomy is most effective.

Part II is written by Hirchberg. It reviews the pathology and anatomy of ulcers of the stomach and gives numerous statistics. It is a satisfactory account on ordinary lines. This book and its companion volume on gastric cancer already reviewed in our pages are two attractive works on gastric surgery.

Chirurgie de l'Estomac et du Duodénum. By HENRI HARTMANN, Professor of Clinical Surgery, Paris. Part II (7th Series of Works on Surgery). Imperial 8vo. Pp. 340, with 142 illustrations. 1928. Paris: Masson et Cie. Fr. 60.

THIS book is a collection of chapters on the surgery of the stomach and duodenum, some of which are written by Professor Hartmann and some by his assistants at

the Hôtel-Dieu, Paris. Although the material is good throughout, probably the most instructive part of the book is the large number of cases which are quoted in connection with each section and which are followed up, in some cases for many years, after operation. It is from a consideration of the after-results that the discussion on treatment is based, and, as might be anticipated, it is highly instructive. There is a particularly detailed discussion of the chronic gastric ulcer, its microscopical appearance, and the question of its being the precursor of carcinoma ; it is interesting to find that of 187 cases of gastric ulcer treated by a short-circuiting operation, 4 subsequently died of carcinoma of the stomach. We do not agree with the statement that the pyloric vein is not a reliable guide to the pylorus, and that to call every ulcer to the left of it 'gastric' and to the right of it 'duodenal' is to base the differentiation on an anatomical structure which is unreliable. In our experience the pyloric vein is remarkably constant in its position.

There is an especially good section on chronic obstructions of the duodenum, their cause and treatment, and attention is drawn to the fact that cases may be diagnosed as duodenal ulcers and treated by gastro-enterostomy. In several of the cases quoted this took place, and at a second operation the true state of affairs was recognized and relieved by a duodenojejunostomy. It is pointed out that the two conditions may co-exist, and that the ulceration is in all probability secondary to the obstruction, and, working from this, the suggestion that all duodenal ulcers should be treated by duodenojejunostomy is discussed, but eventually rejected.

Jejunal ulcers are not considered in any detail, which is perhaps unfortunate, as the formation of a jejunal ulcer after a gastro-enterostomy is certainly the greatest criticism of that operation.

The book is well illustrated, and is an exceedingly good and careful analysis of the gastric and duodenal cases occurring in the practices of the surgeons at the Hôtel-Dieu.

Diseases of the Gall-bladder and Bile-ducts. By EVARTS AMBROSE GRAHAM, M.D., WARREN HENRY COLE, B.S., M.D., GLOVER H. COPHER, M.D., and SHERWOOD MOORE, M.D. Second printing. Large 8vo. Pp. 477 + xv, with 224 illustrations in the text and 7 plates. 1929. London : Baillière, Tindall & Cox. 35s. net.

THE fact that a modern surgeon needs to be something more than a mechanic is made evident by the publication of this work, for although written by three surgeons and a radiologist, it contains the most complete account of the physiology and function of the gall-bladder and ducts that has yet been written. The need of such a work has long been felt, and that the want is now supplied is shown by the fact that the first edition was only published in 1928. Such controversial points as the methods of emptying the gall-bladder, the presence of a sphincter at the opening of the bile papilla, the possible paths of infection of the gall-bladder, and especially the value and methods of use of cholecystography, the discussions of which hitherto have had to be sought in widely scattered journals, are here considered under one cover. The opening chapters are devoted to a lucid anatomical discussion of the gall-bladder and the extrahepatic bile-ducts, and include a useful account of the many variations which are so often a source of difficulty to the practising surgeon. A detailed account of the physiology of the gall-bladder follows, and the many points which are still in doubt are carefully considered. The vast literature that has arisen around the question as to how the gall-bladder empties is carefully dissected and considered, and the authors' conclusions are stated.

The preliminary chapters are followed by a full account of cholecystitis, including the interesting condition known as the strawberry gall-bladder. The arguments in favour of the different possible paths of infection are considered at length. The varieties of gall-stones, their etiology and the methods of formation, are fully described, but it is disappointing to find that stones impacted in the intestine are stated to give symptoms similar to those due to other causes, no reference being made to Barnard's famous description of the classical symptoms. The clinical aspects of cholecystitis are well presented, with a valuable description of the less well recognized symptoms of chronic cholecystitis unassociated with calculi.

It is still accepted that, because cholecystitis is most commonly found in married women who have had children, pregnancy has had something to do with their formation, although no controlled figures have ever been published to show what proportion of women between 40 and 50 who have not got cholecystitis are married and have had children.

The chapter on icterus and cholangitis will be found of exceptional value, as this subject is but briefly discussed in the majority of text-books.

A large proportion of the volume is given over to a consideration of chole-cystography, and since it comes from the pens of the introducers of the method it is at once the most complete and most authoritative account of the procedure. No one who is interested can afford to be without these sections. A curious state-ment is made, however, that it is doubtful if concentrated bile will give an X-ray shadow, whereas with carcinoma of the common duct the pigment calcium in the gall-bladder may be so concentrated that it may be regarded as a soft pigment calculus and may give a well-marked direct shadow of the gall-bladder. There follows another long section devoted to the consideration of the tests of liver function, which, although perhaps outside the scope of a text-book devoted to the gall-bladder and ducts, adds considerably to its value. In the remaining 60 pages there is a discussion of the surgical treatment of the lesions of the gall-bladder and ducts. This section is much less complete in detail and does not appear to have the same authoritative air as the rest of the work. The book as a whole forms a most valuable treatise which no physician, surgeon, radiologist, or clinical pathologist can afford to be without. As a presentation of valuable research work and as a comprehensive review of modern literature it is a credit to the surgery of the United States of America.

Chirurgie des Voies biliaires: **Spiro-cholecystostomie.** By C. SOBRE-CASAS, Chef du Service de Gynécologie de l'Hôpital Torcuato de Alvear (Buenos Aires). With a Preface by Professor J.-L. FAURE. Demy 8vo. Pp. 119, with 33 illustrations. 1928. Paris: Masson et Cie. Fr. 35.

IN the words of the preface this monograph is short, simple, and so well illustrated that the text is nearly superfluous. The story is that of fifty cases of gall-bladder disease in which cholecystectomy might appear to have been indicated, but in which, for reasons of safety, a modified operation was performed without mortality. The modified operation consists of ligature of the cystic duct and artery with: (1) Obliteration of the gall-bladder by a spiral ligature from the cystic duct to the fundus, combined with drainage (spiro-cholecystostomy) ; (2) Excision of the mucous membrane of the gall-bladder combined with the spiral ligature ; (3) Resection of the anterior or posterior wall of the gall-bladder with curettage of the mucous surface left behind. These procedures are intended to supply a safe and yet adequate means of radical cure of gall-bladder disease.

The monograph is very beautifully illustrated with 33 coloured sketches. Such argument as is brought forward is only that of mortality ; nothing is said of the quality of recovery and persistency of cure after the modified operations described. The monograph is of interest, but probably not of great utility.

Fractures and Dislocations. By PHILIP D. WILSON, A.B., M.D., F.A.C.S., Instructor in Orthopædic Surgery, Harvard Medical School; and WILLIAM A. COCHRANE, M.B., Ch.B., F.R.C.S. Edin., University Tutor in Clinical Surgery, University of Edinburgh. Second edition, revised. Medium 8vo. Pp. 789 + xvii, with 1029 illustrations. 1929. London : J. B. Lippincott Co. 45s. net.

IN the second edition of this eminently practical treatise the authors have wisely refrained from increasing its size to any material extent. Brevity and simplicity have been achieved, however, by the omission of a detailed account of many of the more important complications of fractures. Thus, ischæmic contracture, peripheral nerve and vascular injuries are dealt with somewhat scantily. On the other hand, many sections such as the chapter on spinal injuries are admirably presented.

We note that in the treatment of fractures of the lower end of the humerus, the term 'acute flexion' is still employed, and that this position is illustrated, although the dangers of maintaining contact of the forearm with the upper arm by means of strapping are duly emphasized. In the description of ankle-joint fractures the posterior marginal fracture of the tibia, known to Astley Cooper and Dupuytren, is again referred to as Cotton's fracture. In the treatment of malunited ankle fractures no mention is made of the operation of arthrodesis of the ankle. These minor blemishes do not detract from the value of this competent book, which should continue to be of great service to hospital casualty officers and young surgeons engaged in the routine of fracture treatment.

Elements of Surgical Diagnosis. By Sir ALFRED PEARCE GOULD, K.C.V.O., C.B.E., M.S., F.R.C.S., late Surgeon to the Middlesex Hospital, etc. Seventh edition, revised by ERIC PEARCE GOULD, M.D., M.Ch. Oxon., F.R.C.S. Eng., Surgeon to Out-patients at the Middlesex Hospital, Dean of the Middlesex Hospital Medical School. Pott 8vo. Pp. 730 + xv, with 26 radiographic plates. 1928. London: Cassell & Co. Ltd. 12s. 6d. net.

THE seventh edition of Pearce Gould's *Surgical Diagnosis*, appearing forty-four years after the first, proves that it has withstood the test of time, and it is too well known to require any detailed review.

The present edition differs but little from the previous ones, except in the substitution of an Introduction for the first three chapters of former editions. The increase in the value of X rays as aids to diagnosis is exemplified by mention for the first time of lipiodol, pyeloradiography, and cholecystography, but the book impresses on the student throughout that, despite the advances in scientific medicine, bedside diagnosis by the eye and hand forms the basis of correct surgical diagnosis.

Whether as a book of reference or for systematic reading, we can recommend it to the student, and in it he will find the very fundamentals which will enable him to avoid many of the pitfalls of the examination room.

Surgical Radiology. By A. P. BERTWISTLE, F.R.C.S., late Resident Surgical Officer, General Infirmary, Leeds. With an Introduction by D. P. D. WILKIE, O.B.E., F.R.C.S., Professor of Surgery, University of Edinburgh. Post 8vo. Pp. 142 + xi. Illustrated. 1929. London: J. & A. Churchill. 8s. 6d. net.

THIS is a small book of about 140 pages, having ten sections dealing in a very brief way with the usual text-book physiological systems. It is described by the author as " written to meet the demand for a book on the interpretation of radiograms ", and " from the clinical point of view ", but the preface does not state whether it is designed to supplement the already long list of medical 'Aids' series for students. From its title one would expect great things, but after a careful perusal one can only quote Horace's famous line, *Parturiunt montes . . .* , etc. The 21 illustrations are good.

Handbook of Anæsthetics. By J. STUART ROSS, M.B., Ch.B., F.R.C.S.E., late Lecturer in Practical Anæsthetics, University of Edinburgh; and H. P. FAIRLIE, M.D., Anæsthetist to the Western Infirmary and the Royal Hospital for Sick Children, Glasgow. Third edition. Crown 8vo. Pp. 339 + xvi. Illustrated. 1929. Edinburgh: E. & S. Livingstone. 8s. 6d. net.

No one acquainted with Ross's small handbook will be surprised to see a third edition making its appearance within three years of the first. The book has grown considerably, but the authors have succeeded in maintaining the practical nature of the work, and in their attempt to keep abreast of modern teaching and practice they have shown great discretion in their choice of new material. One of the most valuable chapters is that dealing with nitrous-oxide anæsthesia, with its lucid description of the technique of administration.

Where only limited space is available care has been taken that details essential to safety shall not be omitted, a good example occurring in the case of ether-oil anæsthesia, where the advice is given to be content with a 50 per cent instead of a 75 per cent solution, and an incomplete rectal, supplemented by slight inhalation, anæsthesia.

Mr. Wood, in re-editing the section on local analgesia, has dealt with his subject in the same clinical manner so characteristic of the whole of this attractive little book.

The Pressure Pulses in the Cardiovascular System. By C. J. WIGGERS, M.D., Professor of Physiology in the School of Medicine of Western Reserve University, Cleveland, Ohio. Demy 8vo. Pp. 200 + xi. Illustrated. 1928. London : Longmans, Green & Co. 14s. net.

THIS book, whose author is a well-known professor of physiology in America, is one of a series of monographs on physiology. It is concerned with the methods of measurement of the endocardiac pressure, and the interpretation of the records. The author's procedure is to insert a cannula into the ventricle through its wall, or into the auricle through a vein. The cannula is led off to a manometer with a rubber dam bearing a mirror, the movements of which are recorded by reflected light. Dogs are generally used, and artificial respiration is necessary. One outstanding result is the demonstration that the intraventricular pressure is never below zero. This probably accounts for the fact that we no longer stand in dread of serious trouble from air entering the heart through cut veins during an operation on the neck. The differences in type between the subclavian, radial, and femoral pulses in man are figured and discussed. The larger arteries are capable of undergoing local tonic contractions. The book may be warmly commended to those surgeons who retain an interest in the physiological problems of the heart even when the clinical application is not immediately obvious.

The Blood Plasma in Health and Disease. By J. W. PICKERING, D.Sc. Lond., Lecturer on Hæmatology, University of London, King's College. Monographs of Medical and Surgical Science. Demy 8vo. Pp. 247 + xi. 1928. London : William Heinemann (Medical Books) Ltd. 12s. 6d. net.

THIS book contains an excellent review of the modern work on coagulation of the blood and the diseases in which it is altered. The author, who has made this field his special study, has not only discussed the literature of the subject, including his own work, but has made many stimulating suggestions to point the way for further research. Points of clinical importance receive their due attention. The book is of value to physiologist, physician, and surgeon alike.

The Tonsils and Adenoids and their Diseases : Including the Part they play in Systemic Diseases. By IRWIN MOORE, M.B., C.M. (Edin.), late Honorary Surgeon to the London Throat Hospital and Metropolitan Hospital for Diseases of the Throat, Nose and Ear, Great Portland Street. Demy 8vo. Pp. 395+ xix, illustrated. 1928. London : William Heinemann. 21s. net.

THE author has set himself the task of concentrating that which is of importance from the enormous mass of periodical literature relating to tonsils and their diseases. The appearance of such a work is timely, and, although Irwin Moore has himself in the past published a number of papers on the subject, he has succeeded in giving a reasoned statement without undue personal bias. The book is readable, and its value is much enhanced by the number of references to the literature which it contains. In addition to the details of operative technique, the anatomy and pathology of the tonsils are fully dealt with, while the chapter devoted to treatment in cases in which surgical removal is contra-indicated should be particularly useful. The nasopharyngeal and lingual tonsils have each a chapter devoted to themselves, and, under the former, the inclusion of a description of breathing exercises to be used after operation is both an unusual and acceptable feature.

THE

BRITISH JOURNAL OF SURGERY

EPOCH-MAKING BOOKS IN BRITISH SURGERY.

By SIR D'ARCY POWER, K.B.E., LONDON.

X. HUNTER'S OPERATION FOR THE CURE OF ANEURYSM.

So obsessed have modern English surgeons become by the name of Lister that it would be difficult for many of them to say off-hand why Hunter is looked upon, by those who know, as the greatest of surgeons. He was a bad lecturer, a confused thinker, and a very indifferent writer, yet he found surgery mediæval and clinical; he left it a science. How was it done? Go to the museum he collected and let each one see for himself. Study it and the whole science of surgery is displayed in terms of morbid anatomy, comparative as well as human. Many surgeons before him had collected pathological specimens and made museums, but they had used them solely for teaching purposes and they had passed by sale from teacher to teacher. Hunter alone collected not to teach but to learn, and comparing like with like he thought about them and drew wholly fresh conclusions. A few of his contemporaries and the most receptive of his pupils entered into his spirit. To them he was 'the Dear Man'; they had penetrated his shyness and quarrelsomeness, and to them he was a personality ever urging them to follow out his lines of thought. He thus became the founder of a great school of scientific surgery which owed as much to his successors as to himself for its widepsread influence both at home and abroad.

Hunter's work was encyclopædic, for his curiosity was insatiable. We are concerned only with the surgical side, and it is difficult to make a selection. The treatise on inflammation, divested of its rugged style, contains much food for thought and foreshadows many of the surgical discoveries afterwards made possible by advances in chemistry and in physics. The essay on gunshot wounds, based upon only a short experience of actual war, taught that such wounds are not things apart, but should be treated on the same principles as govern other kinds of wounds. The pamphlet upon venereal diseases proved of value, although it was based upon incorrect

premisses and the conclusions were wrong; yet it served its purpose because it led to a very thorough examination of the diseases by those who wished to refute the author.

It is interesting to follow up the line of procedure which Hunter adopted when he desired to unravel a new idea, and this can be done with tolerable ease in the case of his operation for the cure of popliteal aneurysm.

On May 22, 1788, Mr. Edward Ford, living in Golden Square and Surgeon to the Westminster Dispensary, which afterwards became the Westminster Hospital, communicated to the *London Medical Journal* a letter " On Cases of the Spontaneous Cure of Aneurism ". The first history was that of John Cathay, age 36, of Great St. Andrew's Street, Seven Dials, who had an aneurysm of the left popliteal artery which disappeared, though he died afterwards of a right femoral aneurysm. Hunter had seen the case during life as early as September, 1785. He attended the post-mortem examination, secured the specimen, and had it carefully drawn. The second history is that of a man in whom a large popliteal aneurysm was so far cured by prolonged rest that he could walk ten miles without harm. This case Hunter had also seen. Ford was opposed to operation, whether by amputating the limb or tying the artery, on the ground that it usually ended in the death of the patient. He pointed out that the cure by nature is permanent; that the inert mass left behind is not likely to produce any mischief; that the unsuccessful event of the operation for the popliteal aneurysm does not depend principally on any particular hazard in consequence of an obstructed circulation in the ham, but upon other causes; and, most important of all, that if the communicating branches above the tumour are large enough to carry on the circulation in the extremity, the patient may recover, but if they are not, a mortification must of course ensue.

These conclusions were probably formulated after consultation with Hunter, who was living near by in Leicester Square. At any rate, after talking the matter over with Ford and carefully examining the piece of artery which had become converted into what would now be called fibrous tissue, he set to work experimentally. The story is continued by Everard Home in 1793 shortly before the death of his brother-in-law. He says: " Mr. Hunter finding an alteration of structure in the coats of the artery previous to its dilatation and that the artery immediately above the sac seldom unites when tied up in the operation for the aneurism, so that as soon as the ligature comes away, the secondary bleeding destroys the patient, was led to conclude that a previous disease took place in the coats of the artery in consequence of which it admitted of dilatation capable of producing aneurism. But not satisfied with the experiments on frogs, given by Haller in support of the opinion that weakness alone was sufficient to produce the dilatation, he resolved to try the result in a quadruped, which, from the vessels being very similar in their structure to those of the human subject, would be more likely to ascertain the truth or fallacy of Haller's opinion.

" Mr. Hunter laid bare the carotid artery of a dog for above an inch in length and having removed its external coat and afterwards dissected off the other coats layer by layer till what remained was so thin that the blood was plainly to be seen through it, left the dog to himself. In about three weeks

the dog was killed and the parts examined, when it appeared that the two sides of the wound having closed upon the artery, the whole of the surrounding parts were consolidated, forming a strong band of union, and the artery itself was neither increased nor diminished in size.

" This experiment appeared very conclusive, as the coats of the artery were weakened to a much greater degree without dilatation than can ever happen from accident in the living body, independent of morbid affection. But it was objected on the other hand, that the parts having been left to themselves, immediately closed upon the weakened portion of the artery, and, being cemented together by the coagulated blood, effectually secured it against any dilatation. To try the force of this objection, I [i.e., Everard Home] made the following experiment.

" I laid bare the femoral artery of a dog, about two inches below Poupart's ligament, for about an inch in length and dissected off the coats till the hæmorrhage from the vasa vasorum was considerable, and the circulating blood was distinctly seen through the internal membrane of the artery. The hæmorrhage soon stopped by exposure, the surface was wiped dry and afterwards covered with a dossil of lint to prevent the sides of the wound from uniting. The dog continued very well, and the wound healed up from the bottom ; after six weeks the dog was killed and the artery was injected, that it might be examined with greater accuracy. It was not perceptibly enlarged or diminished and its coats at this part had recovered their natural thickness and appearance.

" The results of these experiments confirmed Mr. Hunter in his opinion that the artery, in cases of aneurism, is in a diseased state and led him to believe that the disease often extends along the artery for some way from the sac ; and that the cause of failure in the common operation arises from tying a diseased artery, which is incapable of union in the time necessary for the separating of the ligature. The femoral and popliteal arteries are portions of the same trunk, presenting themselves on different sides of the thigh, and are readily come at in either situation ; but where the artery is passing from the one side to the other, it is more buried in the surrounding parts and cannot be exposed without some difficulty.

" In performing the operation for the popliteal aneurism, especially when the tumour is large, the ligature is commonly applied on the artery at that part where it emerges from the muscles. This mode of performing the operation will be found inadequate if the disease of the artery extends above the sac ; for if the artery should afterwards give way, there will not be a sufficient length of vessel remaining to allow of its being again secured in the ham. To follow the artery up through the insertion of the triceps muscle, to get a portion of it where it is sound, becomes a very disagreeable part of the operation ; and to make an incision upon the fore part of the thigh, to get at and secure the femoral artery would be breaking new ground ; a thing to be avoided, if possible, in all operations.

" Mr. Hunter, from having made these observations, was led to propose, that in this operation the artery should be taken up in the anterior part of the thigh, at some distance from the diseased part, so as to diminish the risk of hæmorrhage and admit of the artery being more readily secured should

any such accident happen. The force of the circulation being thus taken off the aneurismal sac, the progress of the disease would be stopped ; and he thought it probable, that if the parts were left to themselves, the sac with its contents, might be absorbed and the whole of the tumour removed which would render any opening into the sac unnecessary.

" Upon this principle Mr. Hunter performed the operation at St. George's Hospital."

The first operation was performed upon a coachman, age 45, in December, 1785, and the patient died on April 1, 1787, fifteen months after the operation. A post-mortem examination was obtained with difficulty and it was found that the aneurysmal sac had shrunk and was filled with laminated clot.

Hunter performed the operation five times and with sufficient success to show the correctness of his theory that : (1) Slowing of the blood-stream would cure an aneurysm ; (2) Aneurysm was caused by disease of the artery and was not the simple result of long-continued local injury ; (3) So long as there was sufficient collateral circulation gangrene would not result from ligature of the main artery—amputation therefore was unnecessary.

DERMOID CYST OF THE MEDIASTINUM.

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On consulting the literature we find records of 123 cases of mediastinal dermoids. This number is small when we consider that the condition is an arresting one and on this account more likely to be reported, and that this number comprises all the cases recorded over many years in Europe and America. Consequently we feel that the occurrence of such a case is worthy of mention.

CASE HISTORY.

The patient, Mrs. W., age 36, was admitted to the Auckland Hospital on June 11, 1928. She was described as having suffered as a child from a 'weak chest'; at the age of 14 she contracted rheumatic fever, followed by chorea, which lasted
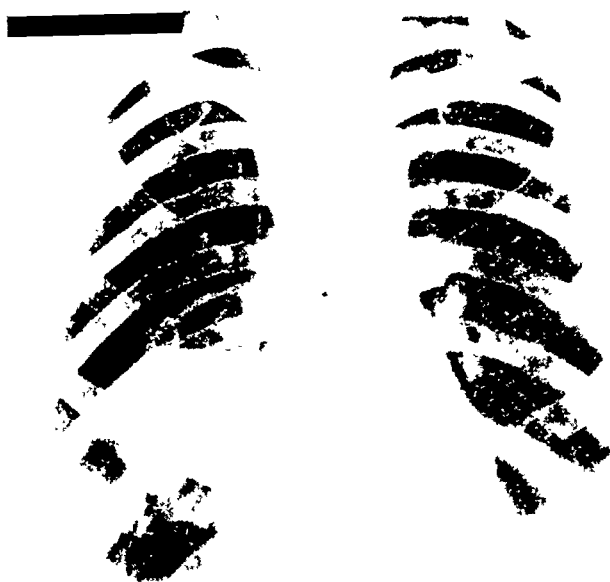
FIG. 129.—Antero-posterior radiogram of chest before operation.

several years, and she was more or less an invalid up to the age of 22. For the last ten years her menstrual history had been normal and healthy, but prior to that periods were scanty and irregular. Patient was a nullipara.

Three years prior to admission she began to have severe paroxysms of coughing, which came on every few weeks. No expectoration followed till eighteen months before admission, when she coughed up a hair. Since then she occasionally coughed up a few hairs during a paroxysm. Three months before admission after a severe bout of coughing she brought up a number of coarse white hairs about three inches long. After this on various occasions she coughed up hairs and sebaceous matter. A fortnight before admission she consulted Dr. Horton, St. Heliers, to whom we are indebted for much clinical information : she had a very severe attack of coughing, with pain in the back and below the right breast. The day before her temperature was 101°, and she was coughing up yellow granules and several hairs. There were no abnormal physical signs in the chest. Temperature fell to normal and the pain was relieved, but she continued to cough up sebaceous material.

Dr. F. J. Gwynne, radiologist, was consulted, and reported as follows (*Figs.* 129, 130) : " In the anterior mediastinum, on the right of the midline, there is a rounded, well-defined, abnormal shadow. It extends between the second and fourth rib-cartilages and is about three inches in diameter. In the erect position the upper quarter containing air is separated from the lower part of the obscurity by a definite fluid level. The findings are consistent with the diagnosis of dermoid cyst of the mediastinum."

FIG. 130.—Lateral radiogram of chest before operation.

At the same time a sample of the sputum was submitted to one of us (R. E. B. B.). The specimen consisted of yellow sebaceous material and a few hairs. Microscopically it showed a few epithelial cells, and enormous numbers of bacteria. No pus cells were seen. Cultures grew *B. coli communis* and diphtheroid bacilli, suggesting a heavy infection but one of relatively low virulence. It was reported that all the evidence pointed to the presence of a dermoid cyst of the mediastinum, which had become infected.

Radiological, laboratory, and clinical findings left no room for doubt. The finding of hairs is regarded as conclusive (though
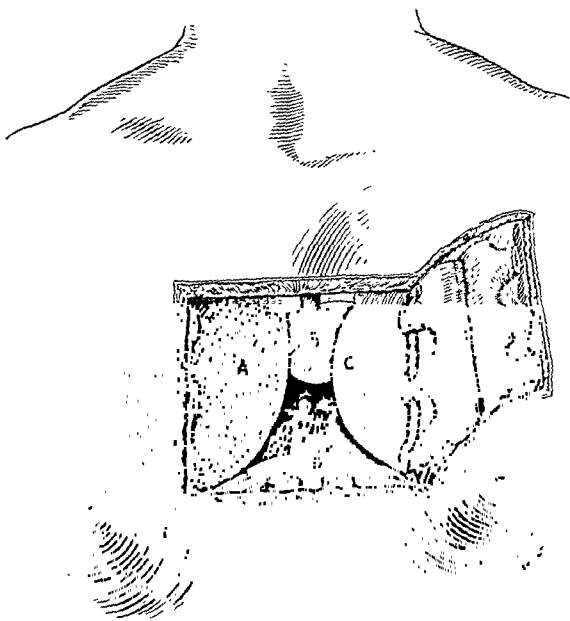
FIG. 131.—Semi-diagrammatic view of the tumour and its relations. Note the bifid sternum. A, Right lung ; B, Dermoid ; C, Pericardium ; D, Diaphragm.

apparently this is a rare occurrence, only eight previous cases of the kind being recorded). No other condition than that of a dermoid cyst rupturing into a bronchus could account for the facts. Radical surgical treatment was regarded as imperative, as, if left alone, the cyst might exert grave pressure symptoms on vital structures, and if through rupture its highly infected contents escaped into the mediastinum, fatal suppuration was almost certain to be the result. Consequently operative measures were decided upon, and carried out by one of us (C. R.) in two stages.

At the first stage (June 15), a trap-door consisting of the second, third, and fourth costal cartilages of the right side and the corresponding piece of the sternum was lifted up. The flap was made to hinge on the left side by dividing the left costal cartilages with a knife. Both the right and left internal mammary arteries were secured and tied. A hard-walled cyst was now felt, deeply placed in the mediastinum. The appearance and relations of the cyst can be seen in *Fig.* 131.

Unfortunately manipulation of the trap-door at this stage resulted in a perforation of the pleura on both sides. The patient immediately collapsed, as no

FIG. 132.—Antero-posterior radiogram of chest after operation.

air entered the trachea. Dr. Gould, the anæsthetist, promptly passed an intra-tracheal catheter and pumped in oxygen. In the meantime the flap was hurriedly scaled down to prevent further air from entering the pleural cavities. Gradual improvement took place, but largely owing to the unstable and excitable mental condition of the patient, convalescence was not a tranquil process for some days.

The second stage was performed on July 6. On this occasion Dr. Gould administered intratracheal ether from the beginning. The trap-door was lifted up, and the cyst was then seen as a whitish round mass, partly covered by and firmly adherent to the anterior border of the right lung. On the left side the pericardium over the right auricle was closely adherent, and covered this part of the cyst. The left innominate vein was adherent to the upper part of the cyst. A patient dissection was now carried out, and as there was no line of cleavage between the cyst and surrounding structures, progress was slow. Considerable difficulty was encountered :

the cyst wall was friable and broke away in many places; posteriorly the cyst extended well into the posterior mediastinum. Eventually it was all removed. No sign of the bronchial fistula was apparent. The cyst was about the size of a small coconut. A drainage tube was put into the depths of the wound and a suction apparatus attached thereto. A free discharge of blood-stained fluid continued for some hours, but the suction drainage removed it before it caused any untoward pressure symptoms. It is almost certain that the pericardium was opened in the region of the right auricle and that the right pleura was again perforated, but the suction apparatus, acting continuously, prevented the serous exudate from the large raw area flowing into these cavities. Our feeling was that the suction drainage was a great factor in the patient's recovery. Save for some superficial sepsis, which for some weeks delayed the healing of the wound, recovery was uneventful. The patient's temperature was normal from the sixth day. She was discharged on Aug. 16. On Oct. 9 she appeared before the Auckland Clinical Society. She was in excellent health, all the symptoms had disappeared, and she complained of nothing at all save occasional tachycardia. An X-ray photograph taken at this time (*Fig.* 132) shows a practically normal chest.

DISCUSSION.

There is a considerable literature relating to dermoid cysts of the mediastinum.

Age Incidence.—If we take the age at the time of operation or death as the age of incidence, cases commonly occur between the ages of 15 and 35, i.e., mainly in young adult life. Usually, however, there have been vague symptoms pointing to a much longer history—to puberty or much earlier. As there is an embryological explanation of their occurrence one might expect symptoms from birth, but of course the cyst may not start to grow till much later—e.g., at puberty. For all that, dermoid cysts and teratomata of the mediastinum have been noted in infants. The history of 'weak chest' during childhood in the case of our patient points to a similarly early origin.

Symptoms and Signs.—There is general agreement that symptoms and signs may be variable or slight. The onset may be insidious, and in a number of recorded cases no tumour was suspected before autopsy. Where symptoms and signs are present they are usually related to the respiratory system : cough, dyspnœa, and free expectoration are relatively common. Hæmoptysis occurs in a few cases. The coughing up of sebaceous material, through rupture into a bronchus, is sometimes seen : more rarely hairs are coughed up at the same time, which is diagnostic. Christian mentions one case of dysphagia.

Pain (felt locally) is relatively rare, and venous engorgement of the neck due to intrathoracic pressure still more so. In one or two cases a visible tumour has appeared above the sternum. Febrile symptoms and general malaise may of course occur. Commonly the diagnosis is made of some pulmonary or pleural disease—e.g., encysted empyema, pulmonary tuberculosis, bronchiectasis, or tuberculosis of mediastinal glands ; sometimes the tumour is thought to be an aneurysm of the aortic arch or an hydatid cyst of the lung. It is said that X-ray appearances are characteristic, and such is our experience in this case.

Course.—The general opinion seems to be that most patients succumb in one to four years from the onset of symptoms unless surgical intervention takes place. We have already referred to the dangers of neglecting the

condition; the cyst may increase in size, and the effects of its pressure on the heart, great vessels, lungs, trachea, or other structures may be serious. If rupture into a bronchus takes place, infection is almost bound to ensue, and such infection involves the grave risk of a mediastinitis. Some writers declare the cyst may become malignant. We do not know how to assess this danger; it may be that such malignant tumours were malignant in the first instance, but we cannot dismiss the danger until we know more. Death may occur sometimes independently or from intercurrent infection.

Treatment.—There is general agreement that complete excision is the only satisfactory method of treatment; but where dense adhesions to vital structures exist such a procedure may be impracticable.

The following is Beye's summary of figures relating to 57 cases operated upon (out of 119 recorded cases) :—

REPORTED CASES	NUMBER OF OPERATIONS (COMPLETE EXCISION OR DRAINAGE)	RECOVERED	IMPROVED	FURTHER HISTORY UNKNOWN	DIED
119	57	22	17	5	12

As these figures include many cases in which complete excision was not attempted, the results cannot be regarded as very unfavourable considering the difficulties of the anatomical situation.

Aurousseau, in an analysis of 38 operations (85 cases), shows the following figures :—

TOTAL NUMBER OF CASES	TOTAL OF OPERATIONS	INCISION AND DRAINAGE	INCOMPLETE EXCISION	COMPLETE EXCISION	CURED	SEQUELÆ	DIED	FURTHER HISTORY UNKNOWN
85	38	—	—	—	19	5	11	3
—	—	21	—	—	3	5	10	3
—	—	—	4	—	4	—	—	—
—	—	—	—	13	12	—	1	—

From this it will be seen that with simple incision and drainage a heavy mortality risk is incurred. The risk is much reduced in the case of complete excision; in the case of incomplete excision the figures are too small to warrant any deductions.

Since Beye's article we can trace 5 more cases, including our own. In 4 of these the tumour was successfully removed. In the fifth case, reported by Poynton and Moncrieff, the patient was an infant, and operative measures were impracticable; a very large teratomatous cyst was found at autopsy.

Pathology, etc.—The origin of these cysts is mostly connected with the branchial arches, and is therefore concerned with the fœtal period of life. Beye quotes an apposite statement by Ewing : " The intimate relations of the ectodermal and entodermal layers of the third and fourth arches may explain the variety of epithelium and the connection with the thyroid and thymus,

while the descent of the heart may carry these structures deep into the thorax. Dermoids of the lower mediastinum may result from imperfect closure of the anterior chest wall." Regarding the latter point, Bland-Sutton suggests that they arise from some fault in the median coalescence of the sternum ; failure of this kind was noted in our patient, whose sternum was bifid throughout its whole length (*see Fig.* 131).

Ewing divides these tumours into simple dermoids and teratoid tumours. The simple dermoids show epidermal lining with dermal glands, and contain sebaceous material and hair. Teeth may be present. The tumours may be unilocular or multilocular cysts. That is to say, simple dermoids arise from ectoderm ; mesodermal and endodermal layers are not represented. "The complex tumours are tridermal, and contain. besides epidermis, bone, cartilage, nervous tissue, intestinal tract, respiratory ciliated epithelium, and thyroid" (Ewing). The same author quotes Ekehorn as pointing out that "the great majority of mediastinal dermoids prove to be tridermal teratomas."

Histological examination of the cyst wall in our case showed an inner lining of squamous epithelium, which in one situation gave place to an exuberant growth of columnar epithelium. Sweat and sebaceous glands, as well as hair follicles, were seen in the subjacent fibrous stroma, as well as some small cysts. There was only scanty evidence of an inflammatory reaction, which is in keeping with the saprophytic nature of the infection present. As the histological findings did not show any mesodermal structures—e.g., muscle and cartilage—the tumour must in our opinion be classed as a dermoid cyst, rather than a tridermal teratoma, in spite of the occurrence of columnar epithelium.

Thus up to date there are records of 124 cases of this condition, and so far as we have been able to ascertain ours is the ninth case where a history of coughing up of hairs has been obtained.

We are indebted to Dr. F. J. Gwynne, of the Radiology Department of the Auckland Hospital, for supplying us with X-ray photographs and his comments thereon.

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CHOLESTEROSIS OF THE GALL-BLADDER:

A CLINICAL AND EXPERIMENTAL STUDY.*

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THE lesions characterized by infiltration of the gall-bladder with cholesterol have occasioned considerable interest since, twenty years ago, the 'strawberry' gall-bladder was first described, and their importance surgically has received increasing recognition.

There are two types of cholesterosis. Of these the better known is the 'strawberry' change, in which the infiltration is widespread. Less common is the type in which localized deposits of cholesterol occur in small polypoidal projections of mucous membrane—'cholesterol polypi'. These types appear to have no essential distinction (the difference of appearance being simply due to the massive localization of cholesterol in the second type, leading to prominence and pedunculation of the mucosa), and it is common to find the two types associated.

It is perhaps not generally recognized that cholesterosis of the gall-bladder, far from being a rare lesion, is actually very common. By the courtesy of Professor Wilkie, the writer has had the opportunity of studying 35 cases, of which 21 have been found during the past year, and it is therefore felt that the time is ripe for a survey of all aspects of the disease, clinical and pathological, and for a report upon experimental work which has been carried out in regard to its pathogenesis.

HISTORICAL.

Although the occurrence of cholesterol in the gall-bladder wall appears to have been recognized a long time previously,[1] the macroscopic picture of cholesterosis escaped the attention of surgeons and pathologists alike until as late as 1909—a fact the more remarkable when it is realized that this condition, far from being rare, is found with considerable frequency both at operation and in the post-mortem room, and is, moreover, of very striking appearance unless obscured by discoloration with bile.

The first description of the naked-eye appearance of cholesterosis we owe to Moynihan,[2] who described and illustrated very beautifully three cases in which the condition was found. At that time it was regarded as being due to innumerable small stones embedded in the mucosa, and it was not until several years later that its true significance was recognized.

MacCarty[3] in the following year described further cases (attributing the appearance to an erosion of the mucous membrane with a secondary bile-staining and fibrosis), and gave the descriptive name of 'strawberry' by which the condition is generally known. More recently Mentzer[4] has applied the term cholesterosis to include all degrees of the disease.

Much of our knowledge of cholesterosis we owe to Boyd,[5] whose masterly paper was published in 1923. In particular, Boyd described in very lucid terms the naked-eye and microscopic appearances, and gave convincing proof of the nature of the lipoid involved in the infiltration.

In recent years the frequency of cholesterosis has led to a somewhat greater interest, especially among French workers, but even yet its importance has not gained widespread recognition.

NAKED-EYE APPEARANCE.

Diffuse Cholesterosis (Strawberry Change).—In a well-marked example of the 'strawberry' gall-bladder the appearance is striking in the extreme (*Figs.* 133–135). The mucous membrane of the whole organ is usually congested and deep red, and scattered over it are innumerable tiny nodular specks of bright-yellow hue, the whole appearance closely resembling that of a ripe strawberry.

The appearance is even more striking, as Boyd has pointed out, if the gall-bladder is examined under a binocular dissecting microscope. In the healthy organ the surface of the mucosa is seen raised up into numerous tall, thin, gossamer-like ridges (which, from their appearance in cross-section are known, incorrectly, as villi) surrounding deep oval or polygonal hollows. In the 'strawberry' gall-bladder these ridges, instead of being thin and tenuous, are stout and swollen, and within them the lipoid is seen as dense or streaky masses, which, in the words of Boyd, load the villi " much as the delicate birch tree might be weighed down by a load of snow."

The lipoid is for the most part confined to the prominences of the ridges, though in rare cases it may also invade the deeper recesses of the wall. In severe examples practically the whole extent of the summits of the ridges is occupied by the deposits, and they then appear as yellow linear streaks running chiefly in a longitudinal direction.

Fig. 133.—'Strawberry' gall-bladder. In the congested mucous membrane are many tiny yellow deposits of cholesterol. One larger polypus is also present. (*D. P. D. Wilkie's case.*)

In other cases the lipoid is deposited, not in streaks, but in pin-head nodules within the villi.

The distribution of the lipoid may be widespread, affecting all the ridges throughout the gall-bladder, but is more frequently patchy. Certain portions seem particularly apt to be affected, and in early cases it is not infre-

FIG. 134.—'Strawberry' gall-bladder. The cholesterol infiltration of the mucous membrane is well marked and extends over the whole of the gall-bladder. (*Sir H. Stiles's case.*)

quent to find a limited area of cholesterosis at about the mid-point of the gall-bladder or towards the neck, and the rest of the organ may appear healthy. Less commonly the lesion may be found only at the fundus.

A curious and important observation is that, when the lipoid deposits are traced along the ridges towards the ductal end of the gall-bladder, they are found, even in the most marked examples, to end abruptly at a point which in some specimens corresponds to the commencement of the cystic duct; while in others it is placed a little

FIG. 135.—The same case as in *Fig. 134*. The ridges of mucous membrane are projecting, distended with lipoid, of pale yellow colour.

closer to the fundus than this point. It is often found that the infiltrated ridges, which for the most part are arranged longitudinally, merge together at this point into a transverse yellow line; beyond this the mucosa appears perfectly free from lipoid.

or at the most there may be one or two tiny seedlets in an otherwise normal membrane.

Cholesterol Polypi.—Here the lipoid, instead of being scattered diffusely over the gall-bladder wall, is aggregated into larger masses in one, two, or more sites. The villus in which it is deposited becomes progressively swollen and polypoid, and eventually may become a large pedunculated mass attached to the wall by the finest of filamentous stalks (*Fig.* 136). The surface of such a mass may be undulating, gyrate, or lobulated. Its colour, when small, is a bright yellow. Later, as increase in size continues, deposition of bile pigments may give it a greenish or brownish hue. In some cases the polypus consists almost entirely of lipoid material, with a thin epithelial covering which may in part be absent ; in others the polypus has a fleshy appearance, with relatively little lipoid. Such polypi may occur singly, or as many as ten or twelve may be present. Not infrequently, in addition, some degree of 'diffuse' cholesterosis is also found.

Associated Disease of the Gall-bladder. — Cholesterosis may occur either alone or in association with various degrees of inflammation. Occasionally it appears to be a definite pathological entity in a gall-bladder which presents no evidence of any morbid change apart from the cholesterol deposits in its wall. To the naked eye the gall-bladder appears of normal blue colour, quite unthickened, and so transparent that the deposits of cholesterol may be visible from the peritoneal aspect before the gall-bladder is opened ; and even on careful histological examination no trace of an inflammatory process is visible. Such cases are, however, uncommon, at least in the examples seen at operation, and only one has been encountered in this series. The majority of cases are associated with some degree of cholecystitis. This may be well marked, the gall-bladder being thickened with old fibrous tissue, but is most characteristically of mild degree. The most common type of gall-bladder to be affected is that which at operation appears just slightly thickened, with some excess of subserous fat and a mild pallor and opacity which mars the healthy blue colour.

Grosser inflammatory disease of the gall-bladder is less common, and this, even when marked, is usually found to be confined principally to the outer

Fig. 136.—Solitary cholesterol polypus, of large size, attached to the subjacent mucous membrane by a delicate stalk.

coats, the mucosa being relatively intact. Cholesterosis never occurs in the presence of extensive scarring or atrophy of the mucous membrane, and is never found as a manifestation of acute cholecystitis (though, of course, an acute inflammation may supervene in a gall-bladder which already contains cholesterol deposits).

Cholesterosis may also, rarely, be associated with malignant disease of the gall-bladder.[5] Gall-stones may be present or absent.

The association of cholesterosis with mild rather than severe cholecystitis has been noted especially by Boyd, who found that in one case, where only part of the wall was infiltrated with cholesterol, the remaining parts showed more profound inflammatory change. He concluded from this that the lipoid deposition was an early phenomenon in the disease process and might disappear as the disease advanced.

Table I illustrates the relation of cholesterosis to cholecystitis in the 35 cases of this series. It will be seen that in 11 gall-bladders showing generalized 'strawberry' change, 1 showed no trace of inflammation either to the naked eye or histologically, 1 was only proved to be mildly inflamed by microscopic examination, and 3 others had a very mild degree of chronic cholecystitis.

Similarly, in 10 cases out of 20 gall-bladders with patchy 'strawberry' cholesterosis, the associated inflammatory change was meagre, and the same was true for all the 4 cases in which polypi alone were found.

In general, the gall-bladders containing stones were considerably more thick-walled than the others, and if these cases are excluded the preponderance of mild inflammatory changes is still further increased, for moderate or gross chronic cholecystitis occurred in only 4 of the 18 cases without stones.

Table I.—RELATION OF CHOLESTEROSIS TO CHOLECYSTITIS.

TYPE OF CHOLESTEROSIS	No. OF CASES	GRADE OF CHRONIC CHOLECYSTITIS					
		None	Recognized only microscopically	Slight opacity of wall	Wall moderately thickened	Wall grossly thickened	Acute exacerbation
* Generalized 'strawberry' ..	11	1	1	3	4	1	1
† Patchy 'strawberry' ..	20	0	1	9	3	6	1
Polypi alone	4	0	2	2	0	0	0
TOTAL	35	1	4	14	7	7	2
Total cases with stones ..	17	0	0	5	4	6	2
Total cases without stones ..	18	1	4	9	3	1	0

* One of these also contained polypi.   † Four of these also contained polypi.

Occurrence of Gall-stones with Cholesterosis.—Gall-stones have been present in nearly half of the cases in this series, namely in 17 of the 35 cases of cholesterosis.

It is of particular interest to note that in the majority of these cases the stones have been composed of pure or almost pure cholesterol, either single stones (cholesterol 'solitaires') or multiple (of 'mulberry' type), and a relationship between the deposit of cholesterol in the mucous membrane and the formation of cholesterol stones seems clearly demonstrated.

MICROSCOPIC APPEARANCE.

General Histological Characters.—It has already been stated that cholesterosis may be associated with divers changes in the gall-bladder wall, and the histological appearance is therefore equally varied. There may be an extensive fibrosis of the deeper parts of the wall, or a less chronic lesion with engorgement of the vessels and some round-celled infiltration, or, on the other hand, the gall-bladder may show no deviation from the normal except for the deposit of lipoids.

In the majority of cases, however, certain characteristic features will be noted. However marked and old-standing the inflammatory changes, they
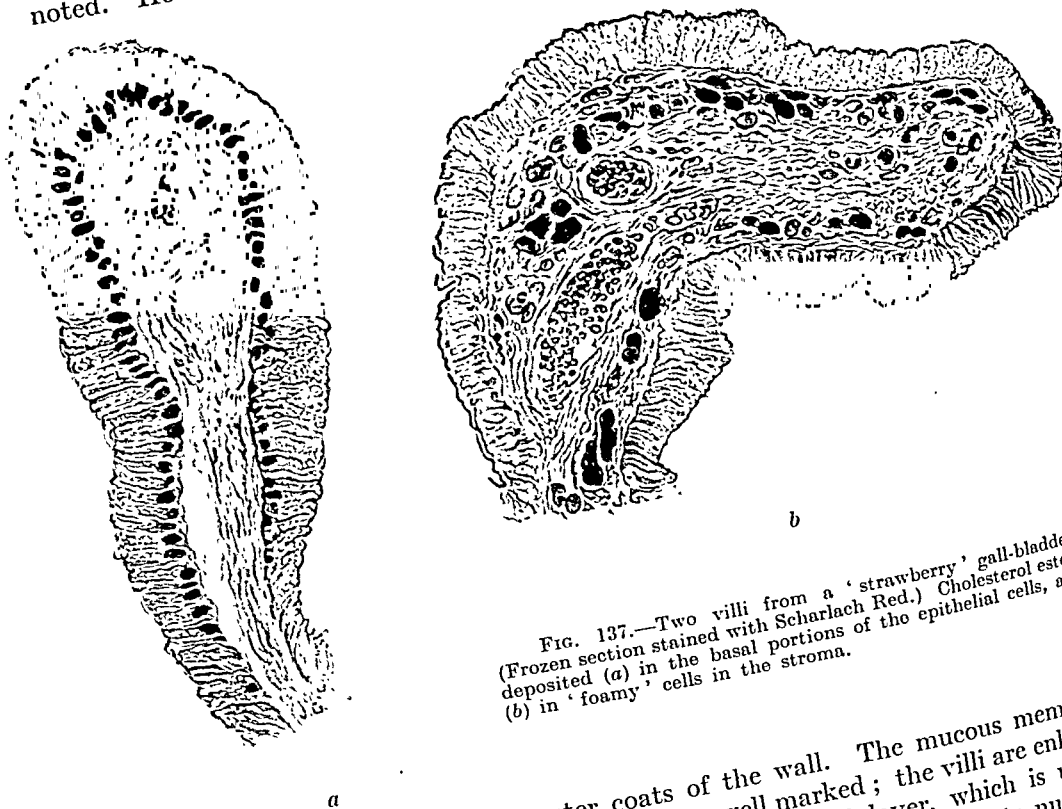
FIG. 137.—Two villi from a 'strawberry' gall-bladder. (Frozen section stained with Scharlach Red.) Cholesterol esters deposited (a) in the basal portions of the epithelial cells, and (b) in 'foamy' cells in the stroma.

are mainly confined to the outer coats of the wall. The mucous membrane usually shows some hyperplasia, sometimes well marked; the villi are enlarged, elongated, and almost pedunculated. The epithelial layer, which is usually complete unless eroded by pressure of stones, may be thrown into numerous

folds which, in sections, sometimes give a false impression of glandular acini. The stroma of the mucous membrane also shares in the hyperplasia. The connective-tissue cells are proliferated, and in addition there is often a mild degree of infiltration with leucocytes. Giant cells of the 'foreign body' type, which occur around many cholesterol deposits, are never seen in the 'strawberry' gall-bladder. A characteristic feature in the stroma is the vascular dilatation, which may be well marked.

Situation of the Lipoid.—The main mass of the lipoid is deposited in the mucous coat, though occasionally in advanced cases traces may also be visible in the fibromuscular layer. In the mucosa the deposits may be either in the epithelium or in the stroma. In some specimens the whole of the lipoid is in the one situation, in others it is in both ; sometimes in the same gall-bladder one portion of the section shows the epithelial deposit, another that in the stroma (*Fig.* 137). Moreover, different portions of the epithelial cells or of the stroma may be affected in different cases, giving rise to variations of appearance which are not readily explicable.

In the Epithelial Cells the most characteristic infiltration of lipoid is at the bases of the cells, in the form of large fatty globules which stain a bright red with Scharlach R. (*Fig.* 137 *a*). These globules are usually localized to the tips of the villi, but in marked cases they may extend to the intervening depressions, forming a sort of scarlet border to the whole section. In this basal situation the lipoid consists mainly of esters of cholesterol.

Less commonly the superficial part of the epithelial cells contains lipoid deposits, in the form of multiple fine granules, which contain little or no cholesterol and appear to consist of unsaturated fatty acids (*Fig.* 138).

In the Stroma of the Mucous Membrane the lipoid occurs characteristically in large amount. Though extracellular deposits have been described, these must be rare, and in all the cases of this

Fig. 138.—Section of 'strawberry' gall-bladder (stained osmic acid). Note the large grey 'foamy' cells (containing lipoid) in the stroma, and the dense black lipoid in the epithelium.

series the lipoid has been situated inside cells of various types.

The most important lipoid-containing cell is one which, from its appearance in paraffin sections, has been called 'foamy' (*Fig.* 138). It is a large mononuclear endothelial cell with a small, dark-stained nucleus and a very delicate reticular protoplasm, in the meshes of which are contained numerous minute droplets of cholesterol esters. Such foamy cells occur at first near the tips of the villi as small rosettes or in linear arrangement (*Fig.* 137 *b*). Later they may collect in large numbers, distending the villi to resemble air

FIG. 139.—Paraffin section from 'strawberry' gall-bladder (stained hæmatoxylin and eosin). The villi of the mucous membrane are swollen by numerous foamy lipoid-containing cells. These are seen as pale areas, from which the lipoids have been dissolved during preparation of the section. (× 100.)

balloons (Fig. 139) and penetrating down into the deeper parts of the stroma (Fig. 140). It is to the mass of lipoid in these foamy cells that the yellow colour of the 'strawberry' gall-bladder is mainly due.

Lipoid may also be found as minute droplets in small elongated or polygonal cells of the stroma, and, less commonly, it may occur in the endothelial cells of blood-vessels. In these two situations it contains no cholesterol.

The occurrence of lipoid has been noted in the lumen of blood-vessels, though this must be a rare phenomenon. Boyd described one case, in which complete proof was lacking, and Bergeret and Dumont[6] have described another. In this latter case actual foamy cells were seen in the lumen of a venule.

FIG. 140.—Frozen section from a 'strawberry' gall-bladder (stained with Scharlach Red). Note the dense masses of cholesterol distending the two villi. (× 50.)

NATURE OF THE LIPOIDS.

Boyd has described with great lucidity the methods in use for the recognition of lipoids, and they require but a brief outline here. It will be recalled that cholesterol and its esters can be most readily distinguished by their property of rotating the plane of polarized light, a property not possessed by other lipoids commonly occurring in the body. Cholesterol can be distinguished from its esters by various staining reactions, and, more exactly, by their melting points, that of pure cholesterol being 148° to 150° C. as compared with 37° to 42° C. for the oleate. Under the polarizing microscope a section of a 'strawberry' gall-bladder presents a brilliant appearance, large masses of anisotropic lipoid standing out in illumination against the dark background of the rest of the tissue. An interesting phenomenon is observed if the section is heated to approximately 40° C. At this point the lipoid masses disappear and their place is taken by numerous large and small 'Maltese crosses' of brilliant white colour, an appearance characteristic of the 'fluid crystalline state' in which the lipoid is physically fluid yet retains the optical properties of the solid.

Boyd has shown that much of the lipoid of the 'strawberry' gall-bladder responds to the tests for esters of cholesterol,* but it must be remarked that this applies only to the lipoid in certain situations (in the 'foamy' cells and in the base of the epithelium). In other parts of the mucosa non-cholesterol lipoid is found, which responds to the tests for unsaturated fatty acids. Thus it is seen that the 'strawberry' gall-bladder is really an infiltration with many complex lipoids, of which combinations of cholesterol and fatty acids are merely one manifestation, though no doubt the most important.†

BACTERIOLOGY.

Whenever possible cultures in Rosenow's brain-glucose-broth medium, or in ordinary glucose broth, have been taken from the gall-bladder wall, the bile, and the cystic lymphatic gland, and in a few cases also from the stones present. In the great majority of cases these tissues have proved sterile, and in the rest no characteristic flora has been found (*Table II*).

*Table II.—*BACTERIOLOGY OF CHOLESTEROSIS.

TISSUE	No. of CASES	STERILE	INFECTED	STREPTOCOCCI	B. COLI	OTHER ORGANISMS
Gall-bladder wall	22	16	6	3	2	1
Bile	23	19	4	2	1	1
Cystic gland	21	19	2	1	0	1
Stone	3	2	1	1	0	0

* Strictly speaking, the tests mentioned apply to mixtures or loose combinations of cholesterol and fatty acids as well as to true esters, and it is probable that in cholesterosis various such mixtures occur. For the sake of simplicity they are here referred to as true esters.

† Since the completion of this paper a case has been observed of a well-marked 'strawberry' gall-bladder in which large masses of lipoid filled the epithelial cells and traces occurred in the stroma. In neither situation was any trace of doubly refractile cholesterol present, all the fat giving the reactions for fatty acids.

CHARACTER OF THE BILE IN CHOLESTEROSIS.

As Moynihan noted in his original paper, the bile is frequently dark, tarry, and extremely concentrated. This is especially the case where the cholesterosis is well marked (Table III), and of the 7 gall-bladders with generalized 'strawberry' change in which the concentration of the bile was noted, all contained tarry bile. Apart from being highly concentrated, however, the bile is quite clear, and it is unusual to find any trace of turbidity.

Table III.—CHARACTER OF THE BILE IN CHOLESTEROSIS.

CHOLESTEROSIS	No. of Cases	CLEAR BILE			Turbid Bile
		Dilute	Tarry	Tarry, with cholesterol flakes	
Generalized 'strawberry'	7	0	6	1	0
Patchy 'strawberry'	15	6	7	0	2
Polypi	2	0	2	0	0

It is true that the condition of the bile in a patient prepared for operation does not accurately represent that usually present, for in the fasting individual rapid concentration takes place; but comparing the bile with that of other patients similarly treated there seems no doubt that undue concentration is the rule.

The Cholesterol Content of the Bile, like its concentration, appears to be increased in cholesterosis. Table IV shows the readings obtained in six cases of this series. It will be seen that there is a very definite increase in the content as compared with the controls, especially where the cholesterosis is marked in extent.

Table IV.—CHOLESTEROL CONTENT OF GALL-BLADDER BILE.

GALL-BLADDER	Cases	Cholesterol Content	Averages
		Mgrm. per cent	
Patchy 'strawberry'	1	466	
	2	445	503·6
	3	600	
Generalized 'strawberry'	1	636	
	2	1033	969·6
	3	1240	
Controls (no cholesterosis)	1	156	
	2	290	329·3
	3	542	

These observations are of interest from two points of view : (1) The high index may account for the frequent presence of stones of pure cholesterol, the result of precipitation from the bile ; (2) As will be considered later, a high cholesterol content may be important as one of the factors leading to cholesterosis.

CLINICAL FEATURES OF CHOLESTEROSIS.

ETIOLOGY.

If surgically removed gall-bladders are carefully examined in the fresh state, a degree of cholesterosis visible to the naked eye is found in a considerable proportion of cases, and well-marked typical 'strawberry' change is by no means rare. In 100 consecutive cholecystectomies during the past twelve months cholesterosis in some form was present in 21, a frequency corresponding fairly closely with that of other observers. In a larger collection of 35 cases of all types of cholesterosis, the well-marked 'strawberry' type was present in 11, and the patchy 'strawberry' type in 20. Cholesterol polypi occurred. alone in 4 cases, and were also present in 5 of those showing the 'strawberry' change.

Sex.—Cholesterosis appears to affect the sexes equally. In the present series men were affected in 4 (or 20 per cent) of 20 consecutive cholecystectomies; women in 17 (or 21·25 per cent) of 80. These figures, being based upon surgical cases in which women preponderate, do not necessarily represent the total incidence in the two series, but it is interesting to note that in a large autopsy series reported by Mentzer[4] a similar close ratio was noted.

Age.—Cholesterosis is a condition chiefly of middle life, though it has been found at the early age of 13. Mentzer states that the average age is 35. In this series the youngest patient was aged 28, the eldest 60, and the great majority exceeded 45 years.

Social State.—Remarkable similarity has been noted in the incidence of the disease in hospital and in private cases. Cholesterosis occurred in 12 (or 21 per cent) of 57 consecutive cholecystectomies in hospital, as compared with 9 (or 20·9 per cent) of 43 private cases.

ASSOCIATED LESIONS IN OTHER ORGANS.

Excluding cholecystitis and gall-stones, cholesterosis seems to have no relationship with other intra-abdominal disease. In 35 cases duodenal ulcer co-existed twice, hydronephrosis once, and pronounced visceroptosis once. Appendicectomy was performed in a considerable number of cases, but usually as a routine measure, and gross chronic appendicitis was present in only 2 cases.

SYMPTOMATOLOGY.

The symptoms presented by patients with cholesterosis of the gall-bladder are extremely varied, and even where other conditions such as gall-stones or marked cholecystitis are absent, the symptoms may be either very severe or entirely lacking.

Other workers have remarked that in cholesterosis the symptoms may be of some severity. Thus, Chiray and Pavel[8] state that the condition is a painful one, sometimes extremely so, and they describe cases in which the predominating feature was that of severe colicky pains recurring at frequent intervals. Fever, they state, is rarely absent at some stage of the disease, and icterus may be observed.

A history of this type has been obtained in four cases of uncomplicated cholesterosis in this series, with the exception that none of them has given

evidence of attacks of fever. All of them had suffered from attacks of pain, which appears to have been intense. One patient volunteered that the pain was worse than that of childbirth, and another stated that it made her roll about and perspire freely. The pain in all these cases closely resembled that of biliary colic, striking the patient in the right hypochondriac region and radiating to the scapula or to one or other shoulder, and necessitating the administration of morphia. In two cases the pain was followed by definite jaundice of several days' duration. In the intervals between the attacks these patients suffered from symptoms like those of chronic cholecystitis, aching pain in the hypochondrium, soreness of the skin in this region, flatu-·lence, and abdominal distension.

In spite of these clearly defined histories of severe symptoms, the gall-bladders in these four cases showed extremely little change except for the presence of gross deposits of cholesterol. No stones were present, and the degree of cholecystitis was very limited. In one case there was absolutely no histological trace of an inflammatory lesion ; in a second such evidence was only obtained on microscopic examination, and in the remaining two the cholecystitis was of a very mild degree. Yet in all four cases the absence of any other gross intra-abdominal lesion and the curative effect of cholecystec-tomy prove that the symptoms had originated in the biliary condition.

The following is a typical case of this group :—

Case 2829.—Mrs. T., age 34, multiparous.

HISTORY.—During the two years previous to admission the patient had had pain on the right side of the abdomen. At first it came in attacks of great severity, which doubled her up and were ' worse than labour pains '. The pain was felt just below the right costal margin and passed to the back below the right scapula. She often had also a pain in the right shoulder. Most of the attacks came on during the day. They might last for a few hours and then pass off, or might recur at intervals over a few days. The pain came is spasms.

Ever since the attacks commenced she had complained of a soreness in the right side, which prevented her wearing tight clothing. She had occasionally been a little yellow-coloured, but definite jaundice had not been noticed. She had no indigestion and could eat any kind of food. Food never relieved the pain. Vomiting occurred when the pain was severe.

OPERATION.—Stomach, duodenum, common duct, and other viscera appeared healthy. The gall-bladder was for the most part of healthy appearance, but seemed a little pale and opaque at the fundus. It was removed. It contained thick, tarry bile, and no stones. The mucosa had the typical appearance of a 'strawberry' gall-bladder, with deposits of cholesterol in linear streaks over a somewhat congested mucous membrane. The wall of the gall-bladder was only very little thickened, and microscopic examination revealed only mild cholecystitis.

PROGRESS.—Reported nine months later : no recurrence of symptoms and is now well and symptom-free.

Such cases with severe symptoms are, however, rare, and the majority of patients give merely a history indicative of chronic cholecystitis—that is to say, the deposit of cholesterol does not appear to aggravate the symptoms due to the accompanying inflammatory change.

In others, again, the disease may be completely symptomless. Such was the case in a patient, age 31, whose only symptoms were those of stiffness in the hip-joint and pains in this region. No signs of local disease of the joint could be found, and as routine examination revealed slight tenderness over

the gall-bladder, this organ was removed as a probable focus of infection—a procedure which resulted in complete disappearance of the pain and joint stiffness. The gall-bladder proved to have a definite, though mild, degree of inflammation, and showed well-marked 'strawberry' change.

CLINICAL SIGNS.

These give little help in the diagnosis of cholesterosis. The general appearance of the patient is in no way dissimilar from that usually associated with cholecystitis, and the patients are usually, but not invariably, well nourished or stout. Local signs are merely those of chronic cholecystitis.

SPECIAL EXAMINATIONS.

Cholecystography.—The appearance of the cholecystogram depends upon the degree of accompanying cholecystitis or upon the presence of stones. If moderate cholecystitis coexists or stones are present, obscurity or absence of the cholecystographic shadow will result ; but, on the other hand, if cholesterosis is accompanied by little inflammatory change, the cholecystographic examination will show no deviation from the normal. Thus, in 8 cases of this series in which deposition of cholesterol was the main change visible to the naked eye, the administration of sodium tetraiodophenolphthalein invariably resulted in a dense 'normal' shadow of the gall-bladder, which, moreover, diminished markedly in size following a fat meal.

This examination (which incidentally indicates that cholesterosis *per se* does not interfere either with the concentrating function of the gall-bladder or with its contractility) is therefore only of value in the diagnosis of cholesterosis in that it may exclude the grosser diseases of the gall-bladder.

Blood-cholesterol Examination. — The cholesterol content of the blood has such a wide 'normal' range of values, and is subject to abnormal increase from such varied pathological or even physiological conditions (e.g., diabetes, parenchymatous nephritis, xanthoma, pregnancy), that the value of this estimation as a diagnostic measure must be limited. The recorded cases of cholesterosis in which blood-cholesterol estimations have been carried out are

Table V.—BLOOD-CHOLESTEROL ESTIMATIONS.

GALL-BLADDER	NO. OF CASES	BLOOD-CHOLESTEROL			
		Low	Low normal	High normal	Raised index
Generalized 'strawberry'	6	0	2	1	3
Patchy 'strawberry'	3	0	1	2	0
Controls : Cholecystitis No cholesterosis	14	4	2	4	4

only two in number, but, in spite of this lack of concrete data, a state of hypercholesterolæmia has been presumed by many writers to be of constant occurrence in cholesterosis. It appears, however, that this is incorrect. In the present series estimations of the blood-cholesterol index have been carried out upon 9 cases of cholesterosis of all grades, and, as a control series, upon 14 cases

operated upon for lesions of the gall-bladder other than cholesterosis. Reference to *Table V* will show that an increased reading was almost as frequently obtained in the control series as in the cases with cholesterosis, and that exactly two-thirds of the latter cases were within the limits of normal. The blood-cholesterol estimation cannot therefore be regarded as of practical value in the diagnosis of cholesterosis.

DIAGNOSIS.

It will be obvious from the varied symptomatology that the diagnosis of cholesterosis must present great difficulties. On the one hand, severe pain simulating biliary colic and followed by transient jaundice will lead to the suspicion that a stone is present in the gall-bladder, and, on the other, the symptoms may be so trifling as to be missed.

In the majority of cases, however, the symptoms and signs point clearly to some lesion of the biliary tract, and the diagnosis of cholesterosis must depend either upon the exclusion of grosser lesions or upon special methods of examination. Of these, the one which seems to offer most assistance in the diagnosis is cholecystography.

It is now generally recognized that cholecystography, though by no means an infallible diagnostic measure, does give an indication either of gross chronic cholecystitis or of the presence of all stones except the smallest, and a 'normal' cholecystographic shadow excludes these conditions. In a patient with a clear biliary history and a 'normal' shadow the diagnosis is therefore narrowed down to one of the following lesions : mild chronic cholecystitis, cholesterosis, or small calculi. It must be admitted, however, that in the present state of our knowledge the diagnosis of this condition can only be tentative.

TREATMENT.

As cholesterosis is rarely recognized until an extirpated gall-bladder has been opened, consideration of the treatment is of academic rather than practical interest. In two circumstances, however, cholesterosis may be recognized at an earlier stage. The yellow deposits in the mucous membrane may be discovered when the gall-bladder is opened for the purpose of cholecystostomy, or occasionally they may be recognized in the course of an exploratory laparotomy, when they may be visible through the thin translucent gall-bladder wall.

In the former circumstances the indication for treatment seems clear. The gall-bladder having already been opened, only two courses are available—either drainage or extirpation. Drainage can have no therapeutic effect upon a disease localized to the wall of the gall-bladder, and is more likely to result in increased traumatization, infection, and scarring of the mucosa. Cholecystectomy is therefore clearly desirable.

The indication in the second circumstance, where cholesterosis is recognized in an untouched gall-bladder, is not so clear, and must be based upon our knowledge of the etiology of cholesterosis, and upon its symptoms and the possibility of spontaneous cure. In regard to this possibility little is at present known, and it is conceivable that in the absence of inflammatory lesions cholesterol deposits may eventually undergo absorption, with complete

restitution to the normal. The observations of Boyd and others, however, indicate that the disappearance of cholesterol is usually associated with an extension of the inflammatory process already present, and the treatment should therefore be directed towards the prevention of this. Medical measures are not known to have any influence upon lesions of the gall-bladder wall, and if symptoms are present which point to the biliary tract, in the absence of contra-indications the operation of cholecystectomy is called for. This treatment has been carried out in all the cases of this series, and, though the period since operation is in most instances too short to justify a final opinion, the results so far seem eminently satisfactory. In 6 cases of uncomplicated cholesterosis which can be traced, the period since operation has varied from six months up to four years These 6 cases include the 4 patients who gave histories of severe symptoms, and all six state that since the operation no recurrence of these symptoms has taken place.

PATHOGENESIS OF CHOLESTEROSIS.

INFILTRATION OR DEGENERATION ?

Throughout this paper cholesterosis of the gall-bladder has been referred to as an *infiltration*, and this description of its pathological significance requires some support. Can cholesterosis be classified as an infiltration of certain cells by cholesterol entering them from without, or may it be the result of a degeneration, i.e., an unmasking of cholesterol previously present in the cells combined in invisible form ?

The whole appearance of the 'strawberry' gall-bladder, with a vast amount of lipoid in a stroma normally scanty and relatively acellular, is strongly suggestive of an infiltration, and this has been quite definitely proved to be the case by Boyd,[5] who showed that whereas the cholesterol content of the wall of normal gall-bladders, estimated by colorimetric methods after extraction in chloroform, ranged from 0·5 to 1·7 per cent of the dry weight, and that of an inflamed, non-cholesterol gall-bladder was 0·36 per cent, the corresponding estimations for 'strawberry' gall-bladders reached the immense figures of from 34·6 to 60·5 per cent.

General Considerations.—Great controversy has raged, especially in French literature, over the relation of cholesterol infiltration to cholecystitis. Gosset[7] and his associates maintain that cholesterosis represents an aseptic process in stone formation. Chiray and Pavel,[8] Lecène and Moulonguet,[9] and others equally insist upon an inflammatory basis, accounting for the cases in which histological evidence is lacking by the assumption that a former cholecystitis has undergone complete resolution. Regarding cholesterosis as a non-inflammatory change, Mentzer has endeavoured to relate it to a general change in lipoid metabolism, and Stewart,[10] amongst others, has regarded it as a result of hypercholesterolæmia.

From the observations which have already been described it must be evident that hypercholesterolæmia is too inconstantly found to be regarded as essential, and the occasional absence of cholecystitis cannot be disregarded, in spite of the view quoted above. Moreover, infection and hypercholesterol-æmia together do not necessarily result in cholesterosis (*see* the controls in

Table V), and clearly other factors must be sought for. It is believed that these may be found in a consideration of the especial relation of the biliary tract to cholesterol metabolism.

The bile is, except for the milk during lactation, by far the most important vehicle for the excretion of cholesterol, and its cholesterol content, especially after concentration in the gall-bladder, may be high. What effect the gall-bladder exerts upon the bile-cholesterol awaits proof. Naunyn[11] has always maintained that the gall-bladder excretes cholesterol into the bile, whereas others believe that it reabsorbs some of the cholesterol into the blood-stream. Whichever view is right, it is believed that some dysfunction of the gall-bladder is intimately concerned in the production of cholesterosis; hence the strict localization of the deposits to the gall-bladder and their absence from the ducts. Before these various features are considered more fully, it will be of advantage to study certain cholesterol infiltrations in other sites in the body.

Other Cholesterol Infiltrations.—Pathological infiltrations with cholesterol, which may occur in diverse situations throughout the body, have been classified by Stewart[10] into two principal categories, according as they result from local tissue changes or from a general increase in the cholesterol content of the body. In many of these infiltrations the microscopic appearance has much in common with that of the 'strawberry' gall-bladder, and the foamy cells in particular are frequently met with. The cholesterol present is usually in the form of the ester, often admixed with other lipoids. It is usually intracellular, but may be deposited in the extracellular tissues, in which case a foreign-body reaction of the giant-celled type may occur. Occasionally the cholesterol occurs in an invisible form, in which it neither stains with fatty stains nor exhibits any optical activity, and can only be demonstrated by chemical analytical methods, being combined, in all probability with proteins, in a masked form.[12]

Certain of these infiltrations deserve especial mention, as they throw some light upon the etiology of cholesterosis.

Cutaneous Xanthoma.—The yellow cutaneous or subcutaneous nodules of this disease are characterized by the presence of foamy cells which closely resemble, both in form and lipoid content, the cells of the 'strawberry' gall-bladder. In regard to pathogenesis, the important feature is the almost invariable finding of a raised blood-cholesterol content, and this is usually regarded as the essential etiological factor. A second, localizing, factor is suggested in some cases, as where xanthoma followed a mosquito bite,[13] and this is supported by the experiments of Anitschkow,[14] who produced xanthomatous lesions in hypercholesterolæmic animals by the subcutaneous injection of aseptic irritants.

Xanthosis of the Fallopian Tubes.—This is a rare finding in cases of chronic salpingitis or pyosalpinx. Pick,[15] and Daniel and Babès[16], have described cases in which cholesterol deposits occurred closely resembling those in the gall-bladder in naked-eye and microscopic appearance. In some cases the cholesterol was distributed uniformly in the mucosa; in others it formed numerous yellow polypi. In these cases there is no evidence of a raised blood-cholesterol index, and the *local* excess of cholesterol in the diseased adnexa has been regarded as of importance.

RELATION OF HYPERCHOLESTEROLÆMIA TO CHOLESTEROSIS.

It has already been indicated that on clinical grounds there is little evidence that a raised blood-cholesterol index can cause cholesterosis. In two-thirds of the cases in which it was estimated the index was normal, and, conversely, it is known that the blood-cholesterol index may reach such immense figures as 1250 mgrm. per cent,[12] yet fail to give rise to cholesterosis.

Experimentally, Blaisdell and Chandler[17] have upheld the view that hypercholesterolæmia *alone* may cause cholesterosis, for in rabbits they have shown that a prolonged course of feeding with cholesterol leads to the deposit of this substance in the gall-bladder wall. This finding, which I have repeated and confirmed, cannot, however, be accurately compared with cholesterosis in the human being, for in animals, if feeding with cholesterol is maintained, as in the experiments referred to, for a prolonged period, cholesterol is deposited in large amounts in the liver, kidney, spleen, adrenals, and other organs, and gives rise to gross atheroma of the aorta and other vessels—lesions which quite overshadow a rather scanty microscopical deposit in the gall-bladder wall.

The following is an extract from one of a series of experiments which illustrate this point :—

Experiment 1.—Cholesterol was administered to four healthy rabbits over periods from 11 to 15 weeks, each rabbit receiving daily, in addition to its usual portion of bran and greenstuff, 0·2 grm. of pure cholesterol, which was administered, for convenience, suspended in butter.

During the period of feeding one of the animals was pregnant on two occasions. The blood-cholesterol index in all cases was very markedly raised to many times its normal value.

At the end of the period the animals were killed. All showed gross deposits of cholesterol in the wall of the aorta and in many other organs, but in only two was there any trace of cholesterol visible in the gall-bladder wall. In these two cases minute droplets were visible, chiefly in the subserous coat of the gall-bladder and to a less extent in the mucosa, but this scanty deposit contrasted markedly with the appearance of the adjacent liver, in which large masses of doubly refractile material were visible.

In one animal at the end of three months the blood-cholesterol content had been raised from 105 mgrm. per cent up to the immense figure of 1136 mgrm. per cent. Excessive deposits of cholesterol esters were present in both kidneys, which were typical gross examples of 'myelin kidney' ; there was a considerable degree of aortic atheroma, and large deposits of cholesterol were present in the adrenals, ovaries, liver, spleen, and other organs ; yet the gall-bladder appeared perfectly healthy to the naked eye, and, microscopically, contained only minute traces of cholesterol.

RELATION OF INFECTION OF THE GALL-BLADDER TO CHOLESTEROSIS.

Diametrically opposed views are held in regard to the importance of the infective factor in cholesterosis. Whilst it is generally conceded that in the large majority of cases a greater or less degree of cholecystitis is present, occasional cases have been reported in which no histological evidence of infection is found, and in view of the fact that most papers on the 'strawberry' gall-bladder are based upon surgical cases which are usually brought to operation on account of an accompanying inflammation, these exceptional non-inflammatory cases are of particular importance.

Gosset and his associates have noted the absence of infection in certain of their cases, and Mentzer from autopsy studies confirms this. In the present series several cases have occurred in which little evidence of inflammation appeared to the naked eye, but in all of these with one exception the microscopic examination gave undoubted evidence of mild cholecystitis. In one gall-bladder, however, although a marked degree of lipoid infiltration was present, no trace of an inflammatory lesion could be found either by histological or bacteriological examination.

In their staunch advocacy of an infectious origin of cholesterosis, Chiray and Pavel have disregarded all histological evidence to the contrary, believing that a mild cholecystitis may disappear, leaving no recognizable trace behind it except the deposits of cholesterol to which it has given rise ; but with our present knowledge of the diseases of the gall-bladder this view seems unsupported. Judging by our present criteria, therefore, it must be admitted that an infection is not essential, though undoubtedly of frequent occurrence, with cholesterosis.

Factor of Biliary Stasis.—It has already been stated that in most cases of cholesterosis the bile is dark and tarry, and this has been taken by some writers as evidence of undue stasis in the gall-bladder. This contention cannot, however, be supported. The concentration of the gall-bladder bile depends not only upon the amount of stasis which exists, but also on two other factors—namely, the bile concentration when excreted from the liver, and the absorptive power of the gall-bladder wall. Clinically, cholecystographic examination of several of the patients of this series showed that the gall-bladder decreased greatly in size after a fat meal, in some of the cases becoming almost emptied, and it may therefore be concluded definitely that biliary stasis has no part in the production of cholesterosis.

EXPERIMENTAL PRODUCTION OF CHOLESTEROSIS BY HYPERCHOLESTEROLÆMIA PLUS INFECTION OF THE GALL-BLADDER.

It was felt that the importance of the factors of hypercholesterolæmia and infection could be most satisfactorily demonstrated by animal experimentation, and, as either of these factors acting alone fails to give rise to gross lipoid infiltration of the gall-bladder, a combination of the two was next attempted : this proved completely successful.

The method employed to produce a chronic cholecystitis was the inoculation of avirulent organisms directly into the wall of the gall-bladder. It is well recognized that in a considerable proportion of chronically inflamed gall-bladders cultures taken from the wall will yield a growth of streptococci which are non-hæmolytic, slow-growing, and avirulent ; and A. L. Wilkie[18] has shown that if these organisms are injected between the layers of the gall-bladder wall, no acute inflammation occurs, but a slowly progressive chronic cholecystitis appears, at first localized to the site of inoculation, but later spreading over the whole gall-bladder. The whole process resembles that seen clinically in cases of mild or moderate chronic cholecystitis, in which inflammatory changes are chiefly localized to the outer coats of the wall, the mucosa remaining relatively intact.

The procedure adopted was as in the following experiment :—

Experiment 2.—A healthy male chinchilla rabbit was fed with 0·2 grm. of pure cholesterol in butter daily, along with its ordinary ration of bran and greenstuff, for

a period of 13 weeks. One week after the commencement of the feeding laparotomy was performed. The gall-bladder appeared healthy. With a syringe and fine needle an intramural injection of a saline suspension of streptococci was then made into the inferior wall of the gall-bladder at its mid-point. The streptococcus was one which had been isolated several months previously from a case of cholecystitis, and belonged to the *viridans* group. For the inoculation the growth from a 24-hour

FIG. 141.—Experimental production of 'strawberry' gall-bladder. In a rabbit, fed with cholesterol to raise the blood-cholesterol content, a mild chronic cholecystitis was produced by injecting avirulent streptococci into the gall-bladder wall. A typical 'strawberry' gall-bladder resulted, clearly recognizable to the naked eye. This section (stained with Sudan IV) shows large masses of cholesterol in the epithelium and stroma.

agar slope culture was suspended in 10 c.c. of saline solution, and about one minim was injected.

Thirteen weeks after the commencement of the experiment the rabbit was killed. At this time it was extremely well nourished and appeared healthy. The abdomen was free from adhesions, the scar of the operation wound being barely discernible. The gall-bladder was of average size ; its inferior surface had an opaque, pearly-white appearance, and on palpation seemed thickened. Its deep

wall, when separated from the liver, appeared relatively normal. The other viscera showed relatively little change to the naked eye, though microscopically deposits of lipoid were visible in the liver and adrenal glands.

The gall-bladder contained a large semi-solid concretion and a few drops of turbid bile. The amount present was insufficient for an accurate estimation, but rough tests showed the presence of cholesterol in excess.

The inner aspect of the gall-bladder presented a striking appearance. Through its whole extent the mucosa was raised up into linear ridges of a bright yellowish-white colour, the whole appearance being very like that of a clinical 'strawberry' gall-bladder, and this similarity was further enhanced by the fact that close up to the commencement of the cystic duct the infiltration stopped completely, the cystic and common ducts being to all appearances free from lipoid.

In frozen sections from the gall-bladder (Fig. 141) the similarity to clinical cholesterosis was completely demonstrated, for the lipoid was found in the two regions where it would be expected—namely, in the stroma and the epithelial cells of the mucous membrane—and much of the lipoid conformed in physical and chemical characteristics with an ester of cholesterol; i.e., it was anisotropic, and it melted, with the production of Maltese crosses, at from 37° to 42° C.

Paraffin sections confirmed the similarity, for, in addition to numerous small cells of inflammatory origin, the stroma of the mucosa contained a number of typical 'foamy' cells, which were most marked in the rather prominent villi, but also extended into the deeper part of the stroma (Fig. 142). In sections stained with osmic acid these 'foamy' cells were seen to contain lipoid granules stained a faint grey.

In another rabbit, similarly treated except that the streptococcal inoculation was made only 4 weeks before the animal was killed, the appearance of the gall-bladder was even more striking. This organ, which was small and somewhat thickened, contained a few drops of fluid bile and a large soft yellow mass adherent to the mucosa. More fluid bile and a large soft yellow mass adherent to the mucosa. More

Fig. 142.—Experimentally produced 'strawberry' gall-bladder. Paraffin section of gall-bladder seen in Fig. 141 (stained hæmatoxylin and eosin). Foamy cells in stroma give an appearance exactly like that of typical 'strawberry' gall-bladders in man. (× 150.)

mass, which was taken at first to be thick pus adherent to the mucosa. More careful examination showed, however, that this was incorrect, and in microscopic sections it was seen that the whole of this mass was composed of large 'foamy'-celled areas situated within the mucosa, the condition being that of a very much exaggerated 'strawberry' change.

It will be seen, then, that cholesterosis of the gall-bladder can be readily produced experimentally by inducing an inflammation of the gall-bladder in a hypercholesterolæmic animal. It remains to be shown how this experimental finding can be correlated with the clinical observation that either cholecystitis or hypercholesterolæmia may be lacking. It is believed that this correlation can best be effected by a study of the function of the gall-bladder in regard to cholesterol.

FUNCTION OF THE GALL-BLADDER IN REGARD TO CHOLESTEROL.

Two opposing views are held in regard to this relationship, namely: (1) That the gall-bladder secretes or excretes cholesterol into the bile; and (2) That the gall-bladder reabsorbs a portion of the cholesterol already present in the bile. There is much to suggest that the latter is the correct view.

The strict localization of the deposit to the gall-bladder itself points to this mechanism, which is in accord with the known absorptive property of the gall-bladder in regard to several other substances; and also the occurrence of cholesterol and other lipoids in the epithelium *of the tips of the villi* suggests that an absorption from the lumen is the route involved.

In the experimental field efforts have often been made to demonstrate the absorption of cholesterol from the bile, but these efforts have had little success. Other lipoids, on the contrary, can readily be shown to be absorbed into the gall-bladder mucosa.

Absorption of Other Lipoids.—The demonstration of lipoid absorption by the gall-bladder wall was first given by Aschoff[19] and later repeated by Mentzer.[4] The former introduced olive oil, butter, and sterile milk into the gall-bladders of dogs, the cystic ducts being ligated to prevent expulsion of the inoculum. In each case it was found that after a period of a few days lipoid deposits were present in the epithelial cells, whereas in control animals, in which simple ligature of the duct was performed, no such appearance was seen. Mentzer noted similar findings. Even after as short a period as half an hour the lipoid could be seen in the epithelial cells, and after longer periods it could be followed to the stroma and even to the vascular endothelium. No particles of fat could be observed in the lymph node draining the gall-bladder, and Mentzer therefore concluded that the absorption took place directly into the blood-vessels.

The following experiments are typical of many that have been carried out, using a variety of fatty and lipoid substances.

Experiment 3.—In a cat the gall-bladder was exposed by laparotomy, and the bile removed by a needle inserted at the fundus. In place of the bile about 1 c.c. of oleic acid (insufficient to distend the gall-bladder completely) was injected, the needle puncture being then closed by a fine silk ligature. To prevent expulsion of the lipoid, the common duct was ligated close above its entrance into the duodenum.

[In other experiments the cystic duct instead was ligated, with similar results. A disadvantage of ligating the cystic duct is that a certain amount of damage to the surrounding lymphatic vessels draining the gall-bladder is inevitable; on the other hand, ligation of the common duct introduces the complication of a complete biliary obstruction, with consequent raising of the pressure within the gall-bladder. Control experiments, using both sites for ligation, were therefore always carried out.]

Two days later the animal was killed. The mucosa of the gall-bladder appeared undamaged, but throughout the entire organ it showed numerous milky-white, tiny deposits, scattered throughout the mucosa along the summits of the ridges—an appearance closely similar to that of a typical clinical 'strawberry' gall-bladder.

Microscopically this similarity was confirmed (except, of course, as regards the nature of the lipoid). In sections stained by osmic acid or by Sudan IV, innumerable fatty deposits were visible in the epithelial cells of the mucosa, in exactly the situation most characteristic of cholesterosis—namely, at the bases of the cells

just below their nuclei, and especially in those cells situated towards the apices of the 'villi'. In other sections the lipoid was sometimes found also in the more superficial parts of the cells, and in some the epithelium was completely loaded with fatty particles (Fig. 143).

The whole appearance of such sections so strongly resembles that of early cases of cholesterosis that it is difficult to believe that in the latter condition the cholesterol can have reached its site of deposition except by absorption from the lumen into the epithelium of the mucosa. The only respect in which the clinical condition differs from that induced experimentally is in the nature of the lipoid, which in the experiment here cited had the staining reactions of a fatty acid and failed to show anisotropism.
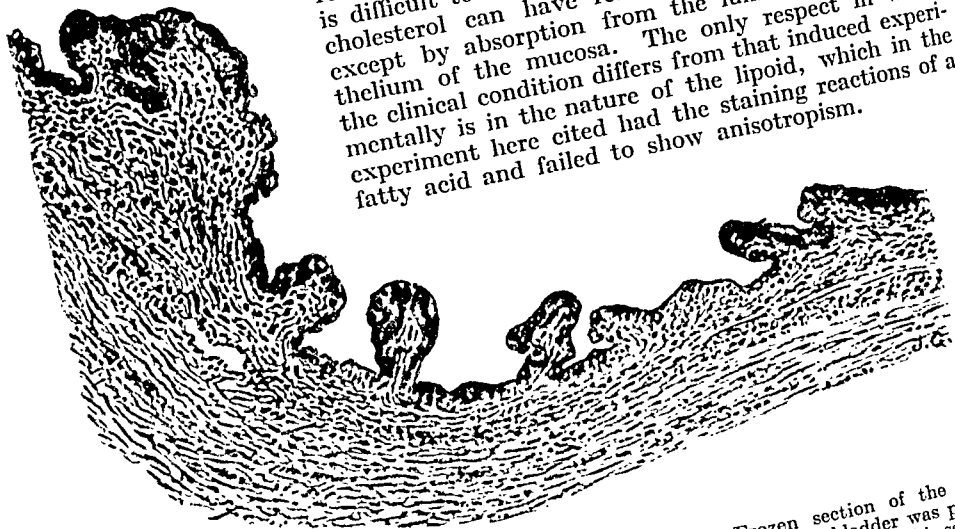
FIG. 143.—Absorption of lipoids by the gall-bladder. Frozen section of the gall-bladder of a cat (stained with Sudan IV). In this experiment the gall-bladder was partly filled with a lipoid (oleic acid), the cystic duct being tied to prevent emptying. This section (taken two days later) shows how a large amount of the lipoid has been absorbed into the cells of the mucous membrane. Olive oil, butter, and several other fatty substances behave similarly. The demonstration of the absorption of cholesterol is more difficult. (× 120.)

In similar experiments the absorption of butter, olive oil, and lecithin has been demonstrated.

Absorption of Cholesterol.—The demonstration of the absorption of cholesterol through the gall-bladder wall has proved difficult. Aschoff in 1906 showed that if cholesterol in olive oil is placed in the gall-bladder, though lipoid appears in the epithelial cells, it does not have the reactions characteristic of cholesterol. Mentzer performed similar experiments, using cholesterol ester, with equally negative results. In addition, cholesterol dissolved in oleic acid was used, and in this case it is stated that absorption took place, though it was not so marked as in the case of other lipoids. Apart from the simple statement, however, Mentzer advances no proof that the absorbed lipoid really was cholesterol, and, unless polariscope examinations are carried out, a fallacy may here creep in.

Experiment 4.—In a cat the bile in the gall-bladder was replaced by 1 c.c. of oleic acid, in which was dissolved 0·2 grm. of pure cholesterol. The common duct was ligated. Two days later the mucosa of the gall-bladder showed evident absorption, and microscopically there was lipoid in many of the epithelial cells. Polariscope examination showed, however, that this lipoid was not anisotropic, and even chemical tests of ethereal extracts of the gall-bladder wall showed but faint traces of cholesterol.

Working from another aspect, Torinoumi[20] has shown how difficult it is to prove that the gall-bladder can absorb cholesterol. Torinoumi, working with dogs, estimated the total cholesterol content of the bile in the gall-bladder before and at the end of a period during which the cystic duct was closed by ligature, and endeavoured to determine whether any reduction of this total took place. Several difficulties attended the performance of these experiments, especially the accidental production of inflammation in the gall-bladder, and the findings were therefore very variable. In those experiments, however, where at the end of the period the gall-bladders appeared healthy, there was a distinct diminution in their cholesterol content, so they do give some evidence of an absorptive function.

It is evident that the proof of the absorption of cholesterol, if it does occur, must be difficult to obtain, for the following reasons :—

1. *The experiments of Torinoumi indicate that absorption is very limited in extent*, possibly depending partly upon a relatively high concentration of cholesterol in the bile as compared with the blood, and slowing down as these concentrations equalize.

2. *The absorption may not be demonstrable by histological methods.* Little is known about the normal method of transport of cholesterol through the body, but it seems probable that the cholesterol is usually bound up with other lipoids in such a manner as to render it unrecognizable by its staining or physical properties. This masking of cholesterol is very evident in absorption through the intestinal mucosa. Thus, in a rabbit which for several weeks had been fed with cholesterol, microscopic sections from several regions of the intestinal tract showed no trace of doubly refractile material, although at the time of death some absorption of cholesterol must undoubtedly have been taking place. It seems possible that the passage of cholesterol through the gall-bladder mucosa may be similarly obscured.

3. In attempts to demonstrate experimentally absorption by the gall-bladder, the physical and chemical state and the environment of the cholesterol used must be of great importance and should correspond as nearly as possible to that present in the normal bile and tissues.

In the course of this investigation numerous experiments have been carried out with the object of giving histological demonstration of cholesterol absorption, but so far they have been entirely unsuccessful. In these experiments, which were carried out on similar lines to *Experiment* 3 above, cholesterol in a great variety of mixtures was used. Crystalline cholesterol, suspended in vaseline, agar-agar, or butter ; solutions of cholesterol in oleic acid or olive oil ; complex suspensions with lecithin and other lipoids ; and extracts of adrenal glands containing much cholesterol : all gave the same results—namely, that absorbed lipoid could be readily demonstrated in the gall-bladder wall, but this lipoid failed to respond to the tests for cholesterol. Although histological proof has been found lacking, it has been possible to demonstrate very clearly the absorption of cholesterol by other methods.

Experiment 5.—A supply of cholesterol, mixed with other lipoids as nearly as possible in the state in which it normally exists in the body, was obtained as follows : The adrenal glands were removed from a number of rabbits which for three months

had been on a diet rich in cholesterol. Frozen sections of these glands showed a large excess of cholesterol, chiefly in the form of esters. The glands were extracted in the cold with chloroform-ether mixture, and a sticky extract was obtained which also showed a high content of cholesterol esters. This extract was emulsified by means of lecithin in a small quantity of cat's bile.

Laparotomy was then performed on two cats, and the same procedure carried out in each. The cystic duct was carefully exposed and freed from the cystic artery, and cut across. With a fine Record needle inserted along the cystic duct the bile in the gall-bladder was withdrawn, and in place of it 1 c.c. of the prepared bile was injected. The cystic duct was then doubly ligatured and the wound closed.

Five days after operation both cats were killed. The gall-bladders, which appeared healthy, free from adhesions, with unimpaired blood-supply and lymph drainage, and with no evidence of leakage, were removed and their total contents carefully collected. Cholesterol estimation was then performed upon these contents, and at the same time upon 1 c.c. of the original injected fluid, all the steps of the three estimations being carried out together to minimize any error.

The results of this experiment are seen in *Table VI*, which shows that during the space of five days more than half of the cholesterol injected had gone from the gall-bladder. This amount far exceeds any possible error of estimation, and as every care was taken to prevent loss during the operative procedure or at autopsy, it seems justifiable to attribute it to actual absorption through the gall-bladder wall.

Table VI.—Absorption of Cholesterol from the Gall-Bladder.

	Cat 89	Cat 98
Cholesterol injected into gall-bladder	34·425 mgrm.	34·425 mgrm.
Cholesterol present after five days	15·67 mgrm.	13·29 mgrm.
Amount absorbed	18·755 mgrm.	21·135 mgrm.

It is concluded, therefore, from these experiments that cholesterol, when in excess and in certain physical mixtures, can be absorbed by the gall-bladder wall, probably in masked form, which prevents its histological demonstration.

DISCUSSION.

It is believed that there are now sufficient data available to justify a tentative opinion as to the etiology of cholesterosis.

The fact that similar infiltrations with cholesterol in various tissues of the body are frequently or usually associated with two demonstrable lesions—namely, an increase in the cholesterol content of the blood and an inflammatory change—necessitates a careful consideration of these factors in particular.

It cannot be doubted, for the reasons already cited, that neither of these factors alone can give rise to cholesterosis, but it is an attractive hypothesis, and one frequently maintained, that they are jointly responsible. Unfortunately this does not completely agree with the available facts, for either hypercholesterolæmia or cholecystitis may be lacking, the former indeed commonly.

In addition, the frequent cases in which hypercholesterolæmia and mild cholecystitis exist, yet fail to give rise to cholesterosis, indicate clearly that other causative factors must be sought for. It seems probable that an indication of the nature of these may best be obtained by a careful consideration of the normal functions of the gall-bladder in relation to cholesterol.

From the experiments described above it seems clear that the gall-bladder can absorb cholesterol from the bile. This does not necessarily mean that such an action goes on to any appreciable extent in the normal gall-bladder (the experiments of Torinoumi indicate that such action must at least be very limited in degree), and it is likely that an essential feature in determining the absorption of cholesterol is the concentration of this substance in the bile, absorption taking place only when it is in excess. Moreover, it is clear that the cholesterol, when absorbed into the healthy mucosa, yet remains indistinguishable under the microscope, its characteristic optical properties being masked in some way not fully understood.

This being the case, it becomes evident that deposit of visible cholesterol in the gall-bladder (cholesterosis) postulates essentially two processes : (1) Absorption of cholesterol into the mucosa, depending probably upon an increase in the cholesterol content of the bile ; and (2) Some change which unmasks this absorbed but invisible cholesterol, and which furthermore prevents or delays its transport and leads to its accumulation in the mucous membrane.

At this point we may see how it is possible to link up this hypothesis with clinical observations.

1. An increased cholesterol content of the bile was found clinically in all the cases in which the estimation was carried out. In 17 of the total cases, moreover, it had progressed to the formation of stones. This cholesterol increase *in the bile* is regarded as a primary factor of importance ; the blood-cholesterol may or may not be increased. In the experimental production of cholesterosis (as in *Experiment* 2) an increase of blood-cholesterol is a necessary intermediate step in raising the bile-cholesterol, but there is much evidence that in man the latter alone may be increased.

2. In the second essential process we can see how the factor of cholecystitis may be linked up with the pathogenesis of cholesterosis, for it is believed that the part played by the inflammation consists simply in interfering with this absorptive process, so that the absorbed cholesterol is rendered visible and at the same time is accumulated in large quantity in the gall-bladder wall.

The exact rôle of the inflammation is open to speculation. Chiray and Pavel[8] have suggested that it acts by actual blockage of the lymphatic drainage of the gall-bladder; but against the acceptance of this hypothesis are two facts, namely : (1) There is no proof that absorption usually occurs by the lymphatic path ; (2) There is no histological evidence of lymphatic obstruction and no œdema or fibrosis of the gall-bladder wall.

A more feasible hypothesis would appear to be that the inflammatory process occurs in virtue of some chemical action directly upon the absorbed cholesterol which would at the same time render the cholesterol visible, interfere with its normal transport, and lead to the characteristic endothelial

response. Such a hypothesis has the additional advantage that it is also applicable to those cases in which no inflammatory element is recognizable. In these cases one may presume some non-inflammatory change in the nature of the absorbed cholesterol, which prevents its transport away from the gall-bladder.

SUMMARY.

1. Cholesterosis of the gall-bladder, which includes the so-called 'strawberry' change and also cholesterol polyposis, consists essentially of an infiltration of the epithelium and the stroma of the mucous membrane with lipoids, and especially with cholesterol. In the stroma a characteristic feature is the presence of large 'foamy' cells of endothelial origin.

2. Cholesterosis is of frequent occurrence. It is a condition chiefly of middle life, and the incidence bears no relation to sex or social status.

3. It is usually associated with cholecystitis, especially of mild degree. Gall-stones are frequently present, especially 'pure' cholesterol stones.

4. Cholecystography indicates that in uncomplicated cases two functions of the gall-bladder (concentration of the bile, and the emptying in response to fats) are not affected.

5. The cholesterol content of the blood is raised in some cases, but is often normal.

6. Symptoms, even in uncomplicated cases, are extremely varied, and the diagnosis is correspondingly difficult.

7. Treatment by cholecystectomy is the most rational procedure, and appears to yield satisfactory results.

8. Experiments are described which indicate: (a) That cholesterosis may be most readily brought about in the rabbit by the association of a prolonged state of hypercholesterolæmia with a mild chronic bacterial cholecystitis; (b) That cholesterosis does not result simply from the deposit of an excess of cholesterol from the blood, but is intimately linked up with the function of the gall-bladder in regard to cholesterol.

9. In an experimental investigation of the absorbing function of the gall-bladder it has been shown: (a) That absorption of several other lipoids from the bile is easily demonstrable; (b) That cholesterol is absorbed in unrecognizable form, its presence in the mucosa being obscured, probably by admixture with other lipoids. Absorption of cholesterol from the bile probably only occurs when it is present in excess.

10. The conclusion is drawn that cholesterosis results from two essential primary changes: (a) An increase in the cholesterol content of the bile, which leads to the absorption of cholesterol into the mucous membrane of the gall-bladder: this increase depends probably upon several factors which are incompletely understood. In some cases it is associated with a similar increase of the blood-cholesterol. (b) A change in the physical and chemical state of the absorbed but invisible cholesterol, which renders it optically active and recognizable, and which by preventing its transport leads to its accumulation in the gall-bladder wall. This change is most frequently due to an inflammation of the gall-bladder.

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SPLENECTOMY FOR EGYPTIAN SPLENOMEGALY:
AN ACCOUNT BASED ON A RECORD OF 390 CASES.*

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SPLENOMEGALY amongst the Egyptian fellaheen is one of the most disabling diseases to which they are prone. There is no doubt in my mind that this enlarged spleen is due to heavy infections of bilharzia of the rectal or *Bilharzia mansoni* types. Proof of this statement is quite another matter, but I am confident it will be forthcoming, and my only regret is that I have no opportunity for field work in this connection, but presently I feel assured the Bilharzia Committee will discover the clue.

I have been performing splenectomy now for the last nine years, and have removed a total of 390 spleens, and I must acknowledge my debt to Owen Richards, at one time surgeon at Kasr el Aini Hospital, who did the preliminary work on this operation, and it is largely through his experiences that I am now accorded a certain measure of success. But it is astonishing how difficult it is to impress the young surgeon with the difficulties of the operation and the precautions that have to be taken, with the result that they get a hundred per cent mortality in their first few cases, and naturally become frightened, and persuaded that the operation is not worth the risk.

It is readily accorded that this procedure is extremely dangerous: not only is the operation itself a dangerous one, needing a gentle hand, a quick eye, and coolness in an emergency, but the material to work on is of the unhealthiest nature. For this reason it cannot be too forcibly impressed upon surgeons wishing to perform this service that the patient must be very carefully prepared before being subjected to the risk of the operation.

I find surgeons examining the stools and urine of these anæmic patients, and if no bilharzia ova or ankylostoma eggs are found, they proceed to operate at once, with fatal results. Whether eggs are found or not, it must be presumed that the patient is full of the common Egyptian parasites, and carbon tetrachloride and a full course of tartar emetic and a course of antisyphilitic treatment must be given and the patient built up by nourishing food. This entails a stay in hospital for at least one month to six weeks. After all this preparation my immediate mortality (by immediate I mean those patients who do not leave hospital alive) is 13 per cent. On following-up patients I find this figure increased to 19 per cent by those who die after getting back to the villages—that is, within two or three months.

I do not choose my cases, but operate on all that come to me if they can

possibly stand the operation, even patients with ascites, which is an unfavourable factor. By choosing cases this mortality can be reduced to 5 or 6 per cent, but 20 per cent will compare favourably with the 40 to 50 per cent mortality of the pioneers in surgery of cerebral tumours, and doubtless we shall reduce our mortality rate as they have reduced theirs in the light of experience.

The difficulty in a country like Egypt is the following-up of patients, and without a good follow-up system a surgeon is very apt to get wrong ideas of his work and statistical results. I have endeavoured by a system of questionnaires sent each year through the police to the omdah or headman of the village to get replies from my cases for three years in succession. The questionnaire is simple : Is the patient still alive ? Has he increased in weight ? Does he feel better than before the operation ? This paper is returned to me :

FIG. 144.—A typical case of splenomegaly before operation, with another case one year after splenectomy.
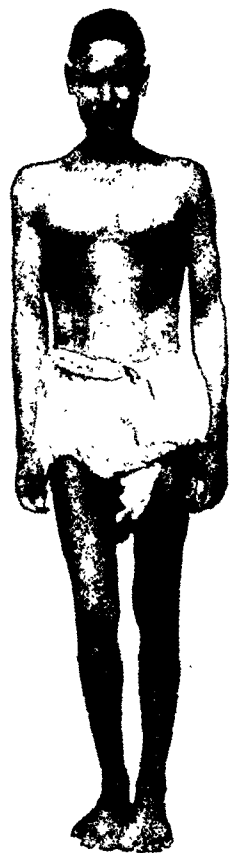
FIG. 145.—Photograph of a patient thirteen months after operation.

I find no trace of 6 per cent of my cases, indifferent health in 5·5 per cent, death in 19·5 per cent, good reports in 69 per cent. A good report of 69 per cent is my justification for allowing the patient to undergo the grave risk of the operative procedure, because it must be understood that without operation their expectation of life is extremely limited. *Figs.* 144, 145 show the good results that can be obtained.

The sexes are probably equally involved, but naturally in Egypt the women do not come forward so readily for treatment as the men, their economic value being so much less. Neither is the accommodation in our hospital sufficient for their needs. My cases show 80 per cent men. The ages vary from 8 to 45, the majority being between 15 and 25.

· The geographical distribution is shown on the map (*Fig.* 146), but more work has to be done on this question. I am inclined to think that villages
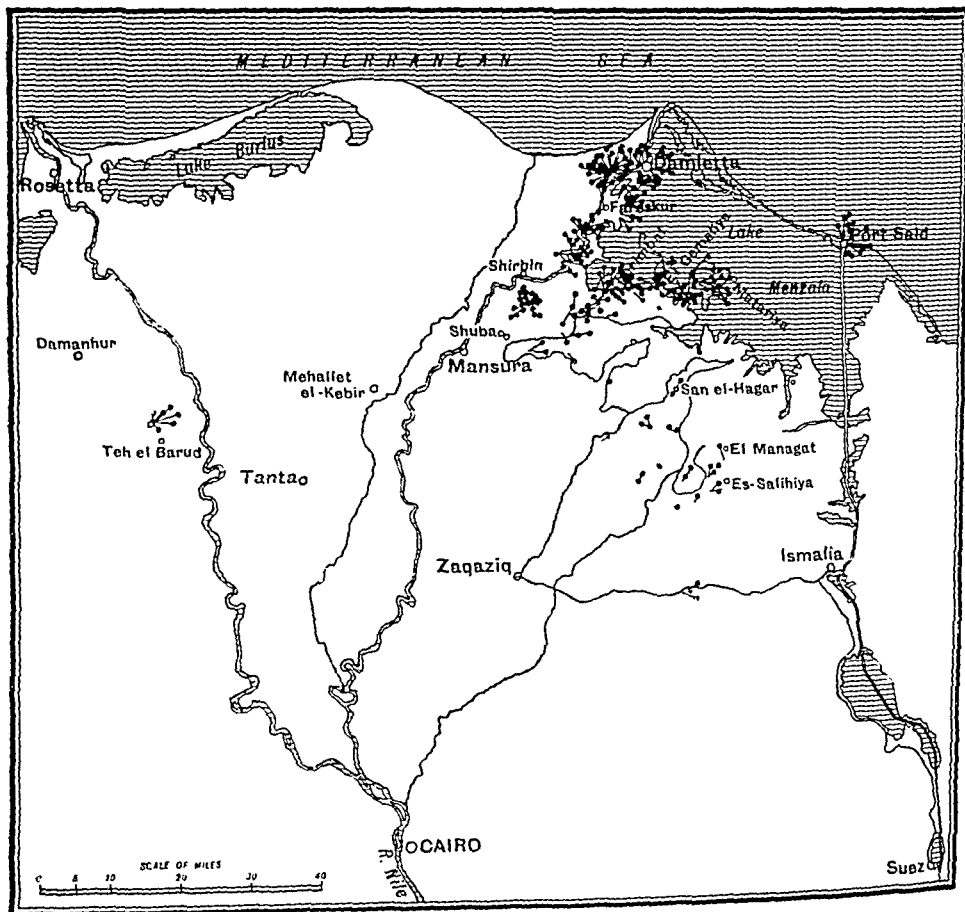
FIG. 146.—Map illustrating the geographical distribution of cases operated upon.

at the end of canals are more heavily infected than elsewhere; but proper surveys, with the help of the Irrigation Department and the Entomological Department as to the distribution of the snails, will demonstrate this more clearly.

Blood-counts on patients will show white count 6500 and red count one or two millions. A differential count will give: polymorphs 66 per cent, lymphocytes 20 per cent, large mononuclears 6 per cent, transitionals 6 per cent, eosinophils 1 per cent, mast cells 1 per cent. The faeces show *Bilharzia*

mansoni, and the urine may be infected also with *Bilh. hæmatobia*, and in addition the fæces may show amœbæ, trichomonas, ascaris, and all the flora and fauna of the country.

The weight of the spleens removed averages 1½ kilo., and varies between 800 grm. and 7 kilo.

PREPARATION OF THE PATIENT.

When a patient is admitted for splenomegaly with a view to operation I give as a matter of routine a dose of carbon tetrachloride varying from 2 to 4 grm. according to age and weight ; a full course of tartar emetic intravenous injections 0·12 grm. every two days for twelve injections ; and a course of injections of '606' or corresponding drug. I give a mixture of rhubarb and soda for the first week (this is a splendid cleaner of the intestinal tract), and subsequently a mixture of iron and arsenic and a full nourishing diet including 'fool nabet', that is, beans which have been allowed to germinate forty-eight hours in water. These are cooked quickly—four or five minutes only—in a good soup. They have a remarkable effect on the pellagrous cases and others suffering from a vitamin-deficient diet. This course of treatment lasts from five to six weeks, when the patient is greatly improved in general health and can stand the shock of operation.

THE OPERATION.

The evening before operation the patient is purged and given an injection of pneumococcic vaccine. This is essential, as, failing this, the patient will almost certainly die from pneumonia after the operation. In fact, about 5 per cent have pneumonia in spite of the vaccine, but with another dose of vaccine they generally pull through. A dose of morphine and atropine is given half an hour before the operation.

The patient sits on the operating table and places his hands over his ears and bends down his head. This opens up the spinal vertebræ, and with a long fine needle on a 2-c.c. syringe, I tap the spinal fluid through the eleventh dorsal space. trying not to let any of the fluid escape and drawing it into my syringe. I then inject about 1·8 c.c. of the stovaine solution, using stovaine 0·04 grm., sodium chloride 0·0011 grm. per c.c.

The patient lies down promptly on his back, and I do not practice raising the legs or lowering the head, as I find there is a smaller percentage of headache after the operation by omitting these procedures. The anæsthesia is good and sufficient for the whole operation ; only very occasionally is a little chloroform needed in addition.

Standing on the right hand side of the patient, I make an incision varying in length with the size of the spleen. This incision starts at the costal margin and runs parallel to the mid-line, dividing the left rectus muscle into two equal parts. I incise the skin and rectal sheath, and make a small incision through the intermuscular septum and separate the muscle with a sweeping action up and down with my finger. The peritoneum is then incised. The exciting part of the operation now follows, as the whole hand

is inserted to find out what adhesions are present between the spleen capsule and the parietes, as the difficulties of the operation depend on the adhesions, and it is impossible to foretell the nature and extent of these obstructions.

In a favourable case, with no adhesions, or only slight easily detached ones, the whole spleen can now be delivered out of the abdominal wound. A dozen big clamps are ready on the instrument table, and I clamp the pedicles of the splenic artery and vein all together with three or four clamps placed in juxtaposition, cutting off the spleen between the third and fourth clamp. The pedicle is then transfixed with a long pedicle needle threaded with a black and white linen thread—a point I learnt from T. de Martel in Paris. Linen is better than silk, and ties in a knot that does not slip. Black and white threads enable one to know at a glance which is which and whether the ligatures are interlocked or not. This first ligature is put in the space revealed by releasing No. 2 clamp, and as it is tied I release No. 1 clamp and allow it to be tied tight. Another ligature is then tied round the whole pedicle in the position of No. 1 clamp, and then a third is tied in place of No. 3 clamp. Various modifications of this procedure have to be undertaken according to circumstances. Very often there is a large vessel running from the greater curvature of the stomach to the hilum of the spleen. I pick up the lesser omentum and tie it off, and thus expose the true pedicle of the spleen.

Frequently there is a very strong adhesion from the splenic flexure of the large intestine to the spleen, and sometimes there are strong adhesions between the spleen and the under-surface of the diaphragm. These have to be broken by the fingers, and after the removal of the spleen, my assistant putting in a wide retractor, I have to pick up these bleeding points with a long bullet-nosed clamp and tie them off. Care is taken to stop all bleeding and clean out the cavity before shutting the abdomen.

The peritoneum is sewn with a continuous chromic catgut No. 0 or 1, and then, with a long Reverdin's needle, three or four supporting silkworm-gut sutures are put in through the skin and the rectus muscle. I then join the tendinous septum of the rectus with a catgut stitch, and subsequently sew up the external sheath of rectus with continuous chromic catgut No. 1 or 2. The skin is closed with Michel's clips and the silkworm gut tied, leaving the ends long, which are again tied over a sausage-shaped roll of dressing to act as a splint.

I have had no cases of paralysis of the inner portion of the rectus muscle in spite of the nerve-supply being divided. I think that breaking the muscle fibres apart with the fingers, instead of cutting, probably pulls the nerve-fibrils out and leaves them to spread quickly across the wound during repair; also, I take it, muscle fibres being contiguous go into contraction with the outer half of the muscle out of sympathy. I am not in favour therefore of the incision which has been suggested for this operation—namely, one starting at the tip of the eleventh rib and running transversely across towards the umbilicus and dividing the rectus muscles. I find no particular advantage in the exposure of the field of operation, and there is peculiar difficulty in sewing up the divided rectus.

After operation patients are kept without anything to drink for twelve hours, my experience being that, given the chance, they will fill their

stomachs with water, and may start hæmorrhage from some unsuspected vessel. As a rule no rectal saline or intravenous blood transfusion is given, as I find that, although the patient may have lost a large amount of blood, he soon makes it up again.

Diet from the beginning is strictly fever diet, and only after five days is a purge given and a nourishing diet commenced. As a rule, patients go out after fifteen days, weak and happy, with a bottle of iron and arsenic, relieved of the intolerable weight in their abdomens, and in two or three months are really fit for work.

CONCLUSIONS.

1. Splenectomy is a dangerous operation requiring especially careful preparation of the patient.

2. The improvement in general health only to be obtained by its means justifies the risk.

THE CAUSATION OF MULTIPLE EXOSTOSES.

By J. B. HUME, LONDON,

THIS condition has been variously described as multiple exostoses, multiple endosteomata, and diaphysial aclasis. All these terms describe to some extent the pathological process involved, for projecting exostoses are present, the cancellous bone is of irregular and abnormal growth, and the ends of the diaphysis are unmodelled. The occurrence of these multiple irregular outgrowths at the ends of the long bones, associated with deficient growth in length and irregularity of contour, has long given rise to dispute among those interested in the problems of bone growth and bone pathology. The problem of modelling is itself ages old, for John Hunter,[1] in his lectures on the " Principles of Surgery ", wrote : " Absorption must necessarily go on to keep the bone in its proper shape, hence I call this the modelling process."

Many cases of this condition have been described, and it is well known to all surgeons and pathologists, so that only a brief résumé of its salient features as affecting the present problem will be given.

No definite information is available as to the exact date of appearance of multiple exostoses. They are not found in embryos or fœtuses, but cases are recorded at the age of two. When the lower end of the ulna is the site of an exostosis the normal ossification of its epiphysis is interfered with, indicating that the process is well established before the age of three (*Fig.* 147). Either sex may be affected. The subjects are of less than the normal stature, owing to the deficient growth of their long bones. Certain bones are never affected; the carpus and tarsus, vertebræ, sternum, and skull are always free from any abnormality, and also the epiphyses of the long bones. It is thus clear that bones developed purely within cartilage or membrane escape, and that only those in which there is additional membrane bone laid down subperiosteally over endochondral

FIG. 147.—The bones of the left forearm of a boy, age 14. Note the tilting of the lower radial epiphysis, the absence of the lower ulnar epiphysis, and the inequality in length of the bones.

bone are affected. The condition is often hereditary, though a history of this is not always obtained. An association with rickets has not been established, but there is a definite association with the occurrence of multiple enchondromata.

Types of Multiple Exostoses. — A number of different forms of multiple exostoses may be recognized, frequently occurring in the same case. The most common are those which occur at the extremities of the long bones, and appear as globular or cauliflower-shaped projections from the cylindrical mass of un-modelled bone (*Fig.* 148). The projections may also take the form of elongated spikes, in which case they are always directed away from the epiphysis, and are nearly always broader at the base than at the apex (*Fig.* 149). In this respect they differ markedly from the single pedunculated exostosis.

In addition to those originating from the region of active growth, we find exostoses occurring near the secondary centres of ossification, such as the gluteal ridge of the femur or the vertebral border of the scapula. These are usually

FIG. 148.—A lateral view of the knee-joint of a youth, age 17. Note the large cauliflower-shaped exostosis on the femur, the globular one on the tibia, and the translucent appearance of the upper end of the tibia.

FIG. 149. —The knee-joints of a girl, age 9, showing spiculated exostoses. The alteration of arrangement in the cancellous bone of the affected area is well shown.

cauliflower-shaped. A few seem to have no connection with any ossification process, and appear as small isolated projections from the centre of the shaft of a long bone, frequently at points of tendon insertion or of muscle origin. These are usually pedunculated. It should be noted that these single exostoses occurring from points of tendon insertion or of muscle origin are the only ones which project from a normally shaped area of bone.

Structure of Exostoses.—It is instructive to recall the mode of growth of the common single pedunculated exostosis, unassociated with any other skeletal abnormality. It is considered likely that a portion of the periphery of the growth disc has become displaced on to the

surface of the shaft, possibly by the pull of the periosteum attached to it. It then continues to grow, its main growth taking place at a right angle to the growth disc. The resultant of the forces in the two directions of growth finally brings the exostosis into a line directed away from the growth disc and at an angle to the shaft of about 30°. It grows by means of a cap of rapidly dividing cartilage which covers its enlarged extremity, and is identical in appearance with a growth disc (*Fig.* 150). The stalk or shaft of the exostosis is always narrower than the cap of cartilage which gave rise to it. Ossification of this cap of cartilage occurs about the age of 20.

Fig. 150.—A pedunculated exostosis growing from a bone of normal contour by means of a cap of cartilage. (Diagrammatic.)

Multiple exostoses are also covered by a thin layer of cartilage until the age of 20, when this layer is replaced by an egg-shell covering of compact bone. The cartilage-covered area extends from the diaphysial growth disc to the point at which the normal contour of the shaft begins, which is always marked by the presence of an out-turned spur or lip (*Fig.* 151). Sections of this surface layer show that the cartilage cells are behaving in the same way as the cells of the diaphysial disc—that is to say, they are dividing and adding more and more cells on their deep surface.

Some of these cells are being replaced by compact bone, which forms an incomplete layer beneath the cartilage. Many gaps are present, and these frequently contain large multinuclear cells. The appearance of the type of growth occurring from the surface cartilage closely resembles that occurring from the diaphysial disc in rickets, though this fact should not be construed into an association between the two conditions.

The cancellous bone underlying the surface cartilage is excessively spongy and fragile, the spiculæ are small and irregular, and the interstices are large and filled with myxomatous tissue. The irregularity of the trabeculæ in the cancellous bone is well shown in radiographs, and may be compared with the characteristic appearance of normal cancellous bone, which has been beautifully illustrated by Murk Jansen.[2]

Bone Modelling.—The process of bone modelling has long been an embryological mystery. The bone once formed increases in length by apposition from the growth disc, and in diameter by the apposition of subperiosteal bone. As new bone cells are formed

Fig. 151.—The right hand of a boy, age 14. Note the out-turned spurs marking the termination of the compact bone at the lower ends of the radius and ulna. Several of the phalanges are involved.

from the growth disc, the broad end adjacent to the epiphysis is displaced towards the centre of the shaft. It has always been assumed that the portion of bone which originated from the periphery of the disc must be removed in order to maintain the contour of the shaft. This process is referred to by Jansen[3] as 'tubulation', and is explained as being brought about by the active remodelling of osteoclastic cells (*Fig.* 152). This whole conception is contrary to the new evidence obtained from tissue culture. Miss Fell[4] has shown that the cartilage cells from a growth area arrange themselves in a definite manner which determines the shape of the bone. It is not that certain peripheral cells are removed in order to produce the normal contour of a long bone, but that the process of cell growth is so perfectly balanced as to bring this about. The two processes of the formation of perichondral and endochondral bone from the subperiosteal tissues and the growth areas respectively go on hand in hand. As there is no evidence of the occurrence of multiple exostoses in the embryo or the fœtus, and as the condition
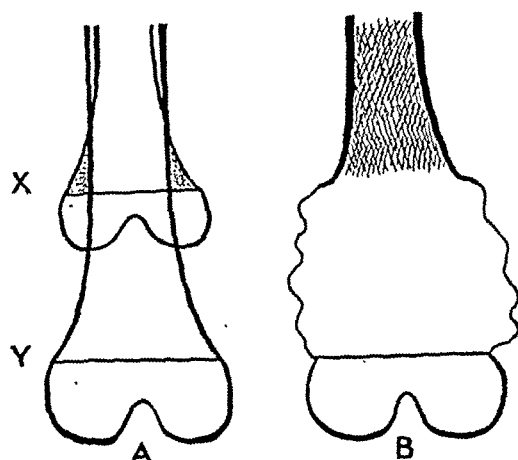
FIG. 152.—A, Illustrating Jansen's tubulation theory. The stippled area represents the portion of bone to be removed during the process of increase in length from X to Y. B, A bone equal in length to Y, showing how the out-turned spurs indicate the position of the growth disc immediately before the process of irregular growth commenced.

is not usually noticed until the third year or later, it is fair to assume that it is not due to any congenital defect in the system of bone modelling.

Conclusions.—Murk Jansen,[3] in his essay on the "Dissociation of Bone Growth", ascribes the causation of multiple exostoses to a dissociation of resorption and tubulation, and mentions no connection between the surface cartilage and the growth of the exostosis. If the defect were merely the failure of the osteoclastic remodelling, a normal formation of bone in respect of length and structure would be found, with possible surface irregularity due to defect in the laying down of surface compact bone which goes hand in hand with absorption. The normal length, however, is not found, and irregularities occur both on the surface and in the medullary cavity. Moreover, up to the time of cessation of bone growth, growing cartilage is found on the surface of the exostosis.

The origin of this surface cartilage would appear to be the key to the situation. It is actively growing, giving rise to osteoid tissue and finally, by replacement, bone. Virchow first drew attention to the presence of growing cartilage on the surface of the exostoses, and though his explanation of its derivation is discarded, probably correctly, by Jansen,[3] yet the facts are basic ones and lend themselves to an alternative theory.

The exostoses are most numerous and best marked at the areas where normally the greatest growth of an individual bone takes place, and are most

frequently found at the upper end of the tibia and the lower end of the femur. This association with the areas of growth would suggest the derivation of the cartilage from which the exostoses increase in size to be from the growth disc, the edges of which have become pulled upwards over the surface of the meta-

physis. This is analogous to the growth of the single pedunculated exostosis from a cap of cartilage, which is a completely isolated portion of the growth disc. It is a matter for speculation how this spreading out-wards and upwards of the edges of the growth disc is brought about. The disc is slightly concave, and the periosteum of the shaft is attached to its circumference. Should the growth of the periosteum and the periosteal bone fail to keep pace with the increase in length of the shaft, the peripheral growing cells become displaced, and in their new situation produce an irregular growth of bone. It is not, however, sufficient to ascribe the condition to a peripheral change alone, as imperfect and irregular growth is taking place from the growth disc as well as from the surface cartil-age, and the type of spongy bone laid down by the two sets of cells is identical. The altera-tion of the normal struc-ture and arrangement of the cancellous bone is very apparent in radio-

Fig. 153.—The hand and forearm of a girl, age 14, showing multiple ex-ostoses associated with multiple enchondromata.

grams of the condition, and normal cancellous bone does not appear until the normally modelled shaft is reached. Growth does not even take place at an equal rate all over the disc, which is proved by the tilting of the epiphysis (see Fig. 147). In a bone such as the femur, for example, two points on opposite sides of the shaft would always have, in normal growth, the same relative distance from the growth disc. In multiple exostoses the spurs marking the commencement of modelling are rarely at the same level, indicating that the process commenced first on one side of the disc rather than over the disc as a whole.

Fig. 154.—A youth, age 17, with multiple exostoses. Note the general deformity of the limbs and the pre-cocious development of the genitalia.

In this connection one point must be considered—the association with multiple enchondromata, which probably originate from a failure of ossifica-tion in the centre of the disc (Fig. 153). In addition to the occurrence of enchondromata, which are often regarded as innocent new growths rather than as growth defect, there is the rare appearance of an osteogenic sarcoma

in the exostoses. The theory of a neoplastic basis for the whole condition must, however, be rejected, because the growth of the exostoses ceases at 20 or 25. It also affects many bones and is to a large extent hereditary. The probability is that there is some defect in the internal secretions controlling bone growth, such as the pituitary or genital gland secretions. Jansen mentions that some of the cases show gigantism (*Fig.* 154). It is well known how the processes of bone growth can be interfered with by alterations in diet, and in the stimulus provided by the internal secretions.

It is clear that such a complicated condition cannot be produced by a mere failure in tubulation, or by vascular disturbance, but that, as Keith[5] originally suspected, the cause must lie in the abnormal behaviour of the cells of the growth disc, and the consequent failure of the subperiosteal bone formation to keep pace with it. An abnormal stimulus affecting the centre of the disc alone, and interfering with the process of ossification, would produce an enchondroma ; one affecting a localized portion of the periphery, a single pedunculated exostosis ; while a more general stimulus affecting the growth discs of all the long bones would produce multiple exostoses.

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ENDOTHELIOMA OF THE NASOPHARYNX: AN INFILTRATING TUMOUR AT THE BASE OF THE SKULL.

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THE tumours which I refer to under the name of 'endothelioma of the nasopharynx' have long been recognized, and were shortly described in this country as long ago as 1911, by Mr. Wilfred Trotter,[1] in a lecture given before the Medical Society of London. That they have not received more attention is due partly to their actual rarity, partly to the fact that they still frequently pass unrecognized, and partly also to their almost unique unfavourability for surgical removal. The recent introduction into general use of radium treatment by means of 'seedling' tubes may, I think, render their early diagnosis a matter of practical as well as theoretical interest, as there is some evidence that this type of growth is susceptible to the influence of radium, and if the difficulties of its accurate application can be overcome, I believe there is ground for hope in this method of treatment. To carry out treatment by this means it is essential that the surgeon should have an accurate knowledge of the method and direction of spread of the tumour.

The disease is one which can occur within wide limits as regards age, and in either sex. Of the nine cases which I propose to use in order to illustrate this paper, three were women and six men. The ages of two of the men were 29 and 31 respectively; of the rest of the patients, four were between 50 and 60 years of age, and three between 40 and 50. The tumour has been regarded as one peculiarly apt to affect the young adult male, but my series is too small to permit of any conclusions, and all that can be said on the subject is that the tumour may occur in young adults, but may equally well be met with in people of more advanced years.

The clinical manifestations of these tumours are so varied that it is no easy matter to classify them, or to state the clinical evidences which justify the inclusion of any particular tumour in the group. Some cases show a quite unmistakable combination of symptoms, while the claim of other cases to belong to the group rests on the occurrence of only one or two of the clinical signs, combined possibly with histological evidence.

I shall attempt to describe these growths under seven principal headings: (I) The clinical appearance and direction of spread of the primary growth; (II) The structures invaded by the primary growth; (III) The clinical characteristics of the glands invaded by the growth; (IV) Remote metastases; (V) The early signs and symptoms of the growth; (VI) The microscopic appearances of the growth; (VII) Possible lines of treatment. To illustrate these points I propose to quote the case records of several patients who have come under my notice in the last few years.

I. THE CLINICAL APPEARANCE AND DIRECTION OF SPREAD OF THE PRIMARY GROWTH.

The primary site of the tumour is to a certain extent obscure, and must, in the present state of our knowledge, be deduced from the early symptoms. Reference to the table of early symptoms which appears in the later part of this article suggests that the tumour very soon comes into relationship with the Eustachian tube, the wall of the pharynx itself, and the 5th nerve. This places the site of origin of the tumour fairly accurately, but whether the growth originates actually in the wall of the nasopharynx is not easy to decide. I am not aware that any case has been recorded in which the symptoms of one of these tumours were present without a palpable mass in the lumen of the nasopharynx, but the syndrome is hardly sufficiently well recognized for such an eventuality to attract attention. From the clinical characteristics of the growth it may be said with certainty that it is not an epithelioma arising in the mucous membrane of the pharynx. The term ' endothelioma of the nasopharynx ' is sanctioned by usage and is sufficiently accurate, provided that one remembers that the symptoms are usually those of an infiltrating tumour at the base of the skull rather than those of a growth in the lumen of the nasopharynx.

When seen in the nasopharynx the tumour is commonly small and sessile and lies in the lateral wall of the pharynx in the region of the opening of the Eustachian tube. It is pink in colour, firm to the touch, and may be only appreciable to the examining finger as a hardening in the wall of the pharynx. Ulceration is either absent or slight in the early stages, and a study of cases in more advanced stages reveals a curious characteristic of the growth—that is, its tendency to spread widely beneath the mucous membrane of the mouth without causing ulceration. The tumour reaches the mouth, I think, by extension down the levator palati muscle. In any case it appears at the junction of the hard and soft palate on one side, and from this position extends widely in the submucous tissue, producing a very pronounced thickening in the alveolus, sometimes as far forward as the incisor region. The older parts of the tumour may ulcerate, but submucous extension goes far in advance of the ulceration.

Any tumour which spreads in the mouth in this manner is under suspicion of a nasopharyngeal origin, and if the tumour has appeared at the junction of the hard and soft palates and has been preceded by neuralgic pain in the distribution of the trigeminal nerve, the suspicion becomes practically a certainty. In two of the cases which I shall presently quote (*Cases 4 and 5*), persistent pain of trigeminal distribution preceded the appearance of the tumour in the mouth by several months, and I have no doubt that the pain in these two cases was due to the unsuspected presence of a nasopharyngeal growth. The tendency to submucous spread without involvement of the mucous membrane can be seen sometimes in the microscopic sections (*see Fig. 157*).

In exactly the same way as the tumour burrows beneath the mucous membrane of the mouth it will burrow in the deeper planes. This leads to infiltration of muscles, to a wide involvement of the structures at the base

of the skull, and may ultimately show as an obvious extension on the outer surface of the skull. Two of the cases which I have personally observed showed this sign. A photograph of *Case 2* is reproduced in *Fig. 155*. The filling up of the temporal fossa on the side of the tumour shows in marked contrast to the hollow on the opposite side in a wasted patient, and produces an obvious alteration of contour of the face.
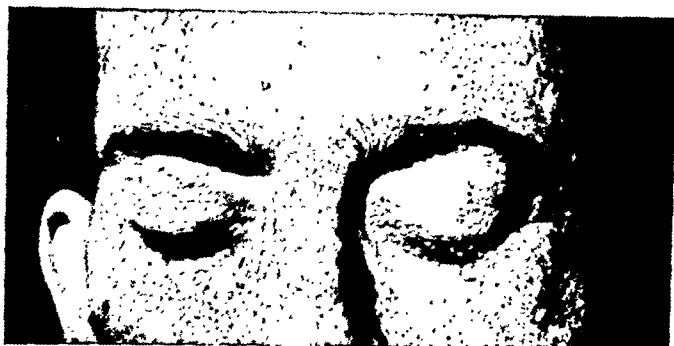
Fig. 155.—*Case 2.* Photograph of the patient J.M., showing the filling up of the temporal fossa on the side of the tumour.

There is no tendency to the formation of a mass of growth in the pharynx at the site of origin of the tumour; in fact it is the exception to see a mass of growth large enough to produce any marked nasal obstruction except in the very late stages.

II. THE STRUCTURES INVADED BY THE PRIMARY GROWTH.

This part of the study of nasopharyngeal tumours is of great interest. By virtue of their anatomical situation these tumours are capable of producing a series of very definite signs while the actual extent of the growth is very small. Also, their habit of spreading widely along submucous and subfascial planes, instead of forming a large mass in the situation of their origin, leads to an involvement of muscles of a very much more definite type than is common in other growths of the mouth and pharynx, and tends to produce a more widespread involvement of nerves, e.g., the intracranial involvement of the 6th nerve.

The structures which may be involved by the tumour may be classified as follows: (1) *Nerves*: the trigeminal nerve, the 6th nerve, the nerves of the palate, other cranial nerves. (2) *Muscles*: the internal pterygoid, the levator palati. (3) *The eustachian tube.* (4) *The cranium.*

1. INVOLVEMENT OF NERVES.

The Trigeminal Nerve.—

First Division.—Involvement of the first division of the trigeminal nerve has not occurred within my experience, and I am not aware that it has been recorded. This is not surprising, as involvement could only occur either by an extensive intracranial spread of the tumour, or by an invasion of the orbit itself, neither of which events is common.

Second Division.—Involvement of the second division is common in the early stages of the growth of the tumour. The symptom complained of is usually 'toothache', and three of the patients in my small series had had teeth extracted on account of toothache before their admission to hospital. As this symptom occurs early and is seldom or never associated with involvement of the first division, it is presumably due to an extracranial involvement of the second division. This probably takes place in the pterygopalatine fossa, a space which is accessible to the growth as it spreads forward on the base of the skull. An alternative possibility, as the pain complained of is usually in the molar teeth, is that the posterior alveolar branches of the nerve are involved as they pass over the tuberosity of the maxilla. Paræsthesia and anæsthesia in the distribution of the maxillary nerve may occur in the later stages, but its absence, even after the pain has persisted for many months, cannot be taken as evidence of absence of a growth.

Third Division.—Involvement of this division is very common, and may almost be said to be a characteristic part of the syndrome. Here again the pain is often of the character of 'toothache', for which teeth may be extracted. Sometimes, however, pain in the tongue (*Case* 1) or on the face is complained of. It is in the distribution of the third division that anæsthesia most frequently occurs. It is curious that the anæsthesia is often most definite in the distribution of the mental branch of the inferior alveolar nerve. I am unable to offer any explanation of this interesting phenomenon, and it does not seem likely that it can be in any way dependent on the confinement of the inferior alveolar nerve within its bony canal, as there is no evidence that the growth in its early stages approaches anywhere near to the canal.

Involvement of the motor division of the mandibular nerve may occur, and results in paralysis of the muscles of mastication on the side of the growth. This condition may be most easily recognized by the deviation of the point of the jaw to the paralysed side which occurs on opening the mouth. This is produced by the unopposed contraction of the external pterygoid muscle on the non-paralysed side. Palpation of the masseter on the paralysed side may be deceptive, as the rotary movement produced by the single external pterygoid turns the ramus of the jaw on a vertical axis, and this movement when felt on the paralysed side may easily be mistaken for a contraction of the masseter. Palpation of the temporal muscles provides an unmistakable physical sign.

The Sixth Nerve.—The 6th nerve is occasionally involved, usually late in the course of the disease, although in one of the cases here recorded it was the first sign of involvement of the nervous system. It is a little difficult to account for this feature of the growth, but I think most probably the nerve is attacked either directly or, more probably, by an interference with its vascular supply, in the short interval between the point at which it pierces the dura mater and that at which it enters the cavernous sinus. It lies here on the dorsum sellæ, and would be easily attacked by an upward extension of the growth either through the carotid canal or directly through the sphenoidal sinus. That extension in this direction does occur is shown by a radiogram of one of my cases (*Case* 1) in which erosion of the dorsum sellæ is seen to have taken place, and also by the post-mortem findings in *Case* 2.

The Nerves of the Palate.—A proportion of cases shows involvement of the palate other than by direct extension of the growth. The proportion in the cases here recorded is small (two in nine), but paralysis of the palate is regarded by some as one of the cardinal signs of endothelioma of the naso-pharynx and consequently must be considered. It has been held (Trotter[1]) that the paralysis of the palate is due to infiltration of the levator palati as a result of a direct extension of the growth. This appears to me improbable, as in this case one would expect a condition analogous to the trismus which arises from infiltration of the internal pterygoid—that is to say, a hardening and shortening of the muscle, producing a *raised* and immobile palate. This condition I have never seen, nor is it mentioned in any of the case records which I have consulted. Further, in the case in my series which showed paralysis of the palate there was also anæsthesia of the *soft palate*—no amount of manipulation of the soft palate causing the patient the slightest discomfort. In the later stages of the disease the soft palate may be rendered immobile by direct infiltration of the growth.

The association of paralysis of the soft palate with anæsthesia is difficult to explain if one accepts in its entirety the work of Aldren Turner[2] on the innervation of the soft palate. It is generally agreed that the sensory innervation of the soft palate is obtained from Meckel's ganglion. Previous to the work of Aldren Turner it was held that the muscles of the palate, with the exception of the tensor palati, were supplied by the facial nerve through Meckel's ganglion, while the tensor was supplied by the motor division of the 5th nerve through the otic ganglion. Turner's work gives good evidence that the nucleus concerned is not that of the facial nerve, but those of the vagus and accessory; the evidence concerning the subsequent course of the fibres, however, is not so clear.

Turner's statement that "the muscles of the soft palate derive their motor supply from the pharyngeal plexus through the pharyngeal branch of the vagus" is supported only by the results of experiments on dogs and by one case recorded by Dr. Bastian,[3] in which excision of Meckel's ganglion was performed without giving rise to any palatal paralysis. More recent work by A. R. Rich[4] suggests that the tensor palati is really supplied by the 5th nerve. According to this author, paralysis of the tensor gives rise to no deformity of the palate, and can be recognized only after stripping the mucous membrane from the muscles. He has performed this operation on dogs and has observed paralysis of the tensor palati after section of the mandibular division of the 5th nerve. If Rich's work is accepted, the clinical 'paralysis of the palate' is simply a paralysis of the levator palati. As regards the origin of the nerve-supply of this muscle, he agrees with Turner in attributing it to the 11th nucleus, but again gives no convincing account of the subsequent course of the fibres.

There are several circumstances which suggest to me that the course is not through the pharyngeal branch of the vagus nerve. One of these is the coincidence of anæsthesia with paralysis of the soft palate, and another the much more frequent occurrence of paralysis of the palate than of signs pointing to involvement of the 10th and 11th nerves (cf. Woltman's table in the abstract of the literature—p. 260—in which the incidence of palatal paralysis

is exactly that of involvement of the motor division of the 5th nerve and much greater than that of involvement of the 11th nerve).

A possible course for the fibres between the 11th nucleus and the levator palati is through the jugular ganglion of the vagus and thence by the auricular nerve to the facial nerve. The further course would then be by way of the greater superficial petrosal nerve and the nerve of the pterygoid canal to Meckel's ganglion. This is a suggestion admittedly quite unsupported by experimental evidence, but it furnishes a reasonable explanation of the coincidence of anæsthesia and paralysis of the soft palate in the type of case which I am describing, and renders understandable the traditional association of paralysis of the palate with facial paralysis.

Since this article was written, Mr. Julian Taylor, of the staff of University College Hospital, has very kindly drawn my attention to a case which came under his care a short time ago and which appears to have an important bearing on the question of the course of motor nerves to the soft palate. The case history was as follows :—

A man, age 26, was admitted to hospital fourteen weeks after a motor-cycle accident. At the time of the accident there had been definite concussion, with retrograde amnesia, and, according to the statement of the patient, bleeding from the right ear and the throat. There was also swelling of the right eye. On admission the patient showed the following nerve lesions, all of which were on the right side.

Second Nerve.—Complete loss of sight in the right eye, with loss of direct (not consensual) pupillary reaction.

Fifth Nerve.—Motor : Paralysis of the muscles of mastication. Sensory : Diminution of sensory acuity and parasthesia in the distribution of the second and third divisions.

Chorda Tympani.—Perception of taste on right half of tongue delayed and incomplete ; ordinary sensation over tongue normal.

Palatal Nerves.—" When the palate is raised the uvula is seen to be displaced upwards and to the left with flattening of the right half of the arch."

The rest of the cranial nerves showed no impairment of function. In the radiogram a crack could be seen in the right parietal bone.

Here, then, is a patient who has certainly had a fracture in the middle fossa of the skull on the right side. There is no evidence whatsoever of any lesion in the posterior fossa. He shows among the cranial nerve lesions a paralysis of the soft palate, apparently of the levator palati—I say this because in a very full and accurate description of the case there is no mention of deformity of the palate at rest. It is almost inconceivable that the lesion of the palatal nerves can have occurred at any other place than in relation to the base of the middle fossa of the skull. A study of the anatomy of the middle fossa of the skull shows that the hiatus of the facial canal (from which issues the greater superficial petrosal nerve) lies immediately above the inner end of the petrotympanic fissure (through which the chorda tympani leaves the skull), and that both are in close relation on their inner side to the motor division and second and third sensory divisions of the 5th nerve.

I regard this case as evidence in favour of the view that the motor nerve supply of the levator palati is carried by the greater superficial petrosal nerve, and as showing practically beyond doubt that, whatever may be the exact course of the fibres, they are in relation to some part of the middle fossa of the skull and not derived " from the pharyngeal plexus through the pharyngeal branch of the vagus."

Other Cranial Nerves.—Reference to the review of the literature at the end of this article will show that there is no cranial nerve which has not been observed to be involved in the extension of a malignant nasopharyngeal

growth. This observation is not of any value for my present purpose, owing to the fact that in these records the various types of nasopharyngeal tumour are not well distinguished. It is clear that in the terminal stages of the endothelioma there may be extension of the growth so as to invade the nerves of the jugular foramen. This was present in one of my cases, roughly nine months after the onset of the disease, which in this case ran a particularly rapid course. Paralysis of the sympathetic on the side of the tumour was also present, although there were no palpable glands in the neck. The unfortunate patient was in a truly pitiable condition, being unable to hear owing to involvement of the Eustachian tubes, and unable to speak or swallow from paralysis of the muscles of the larynx and pharynx. In this case paralysis of the pharyngeal muscles was responsible ultimately for the death of the patient from inanition.

It is also beyond doubt that an intracranial spread of the tumour, without being extensive, can involve other nerves in the anterior part of the middle fossa. In this way the 2nd, 3rd, and 4th cranial nerves may be involved, but such an event is not common. It has occurred once only in my own experience, and this at a very late stage. However, in view of the occasional early involvement of the 6th nerve, which I believe is due to a direct invasion either of the nerve or of its blood-supply in the immediate neighbourhood, it is not impossible that cases may arise in which the spread of the growth occurs in such a manner as to lead to the early involvement of the 2nd, 3rd, and 4th nerves.

2. INVASION OF MUSCLES.

The Internal Pterygoid.—This muscle may be infiltrated directly by the growth. When this involvement occurs it leads to trismus of a greater or less degree. Trismus does not necessarily occur even in the late stages of the disease, and as far as my own cases are concerned its presence was only observed in three. On the other hand, in *Case* 2 trismus was the earliest sign referable to the growth as distinguished from its metastases.

The Levator Palati.—I have already stated my reasons for believing that direct involvement of this muscle is rare. None of my cases showed the physical signs which one would expect if this muscle were infiltrated by growth. It is, however, recorded by Trotter.

3. INVOLVEMENT OF THE EUSTACHIAN TUBE.

The growth originates close to the pharyngeal opening of the Eustachian tube, and commonly causes, sooner or later, an obstruction of the lumen of the tube. This leads first to deafness on the side affected, and sometimes later to an otitis media. Unilateral deafness is a very characteristic early sign of the disease. It is only recorded in four of my cases, but I think this gives a false impression of its frequency, as it is a sign which may easily be overlooked when the patient has other more prominent signs. There is, however, one recorded case in which deafness was looked for and found to be absent.

Otitis media may result from continued obstruction to the Eustachian

tube. It was present in the later stages of one of my own cases, and was observed in one of Trotter's cases in which the growth recurred after removal. It is also mentioned by New.[5]

4. INVASION OF THE CRANIAL CAVITY.

This has been recorded fairly frequently. Involvement of the 6th nerve is, as has already been stated, probably due to an intracranial extension of the growth; also the radiogram of the skull in one of my own cases showed erosion of the dorsum sellæ. Gross clinical evidence of intracranial invasion is not, however, common. Reverchon[6] refers to it and to relief of the accompanying symptoms by lumbar puncture and subtemporal decompression. New refers to the possibility of an intracranial extension of one of these tumours being mistaken for a primary endothelioma of the Gasserian ganglion. This mistake has apparently occurred when the ganglion has been exposed for a supposed 'major neuralgia' of the 5th nerve. The error does not appear to be a likely one, as the clinical signs concerned with the 5th nerve in true 'trigeminal neuralgia' are very different from those which are seen in endothelioma of the nasopharynx. Intracranial extension does occur, and should be considered in estimating the suitability of any particular case for treatment; but none of the cases I have seen, even in their terminal stages, showed any gross clinical sign of intracranial involvement beyond the paralysis of cranial nerves. *Case* 1, when seen shortly before his death, had no headache and no sign of intracranial extension, although the radiogram taken five months previously showed erosion of the dorsum sellæ. Post-mortem evidence is regrettably scarce, but in the few available records intracranial extension is frequently mentioned. Probably before death most of these tumours do invade the cranial cavity, but it must be emphasized that the signs of a cerebral tumour or even of increased intracranial pressure have no place in the clinical picture of the cases with which I am dealing. I mention this particularly as there is a tendency among the French authors to speak of these growths as if intracranial invasion were an early and prominent feature, whereas in the experience of others, although the intracranial invasion may take place early, it gives rise to physical signs either very late or never.

III. THE CLINICAL CHARACTERISTICS OF THE GLANDS INVADED BY SECONDARY DEPOSITS.

This part of the study of these tumours is both interesting and important to the clinician. As Trotter has pointed out, the type of glandular enlargement is highly characteristic, so much so that to one who is familiar with the condition the discovery of glands of this type in a young person is sufficient to suggest the site of the primary growth. The importance of being able to recognize these glands lies in the fact that glandular enlargement may occur before the primary growth has given rise to any gross physical signs.

The glands involved are those of the upper deep cervical group, and frequently invasion on both sides of the neck is simultaneous, or practically so. The site of the earliest invasion is, unfortunately, not characteristic;

commonly the largest glands, and presumably the earliest affected, are those lying on the jugular vein behind the angle of the jaw. From here the invasion extends to affect the whole deep cervical group, and ultimately sometimes the glands of the posterior triangle. Invasion of the retropharyngeal glands appears to be rare ; none of my cases showed any sign suggesting such an invasion, neither is it mentioned in any operation notes or post-mortem record which I have consulted. Neither has invasion of the glands in the parotid region occurred in my experience, nor apparently in that of other writers on the subject. Consequently the distribution of the glands invaded is different from that found in malignant disease in other parts of the pharynx and mouth only in that the invasion is commonly bilateral in the early stages and may occur before the primary growth has given rise to any symptoms. Such a combination of signs in a young patient may easily lead to a diagnosis of tuberculous disease or lymphadenoma.

It is accordingly necessary to lay some stress on the character of the enlargement, which is, in my opinion, more helpful than the distribution. The glands are extremely hard, and very early become fixed to surrounding structures. Yet at the same time they remain distinct from one another, and the fixity is rather of the type produced by a widespread inflammatory reaction outside the capsule of the gland than of growth extending through the capsule. The impression produced on the examining hand is that of a number of hard glands fixed together by a softer fibrous mass. The glands are frequently tender to palpation to a greater degree than carcinomatous glands at the same stage of involvement.

In Trotter's paper the clinical appearance of the glands is compared with that produced by tuberculous disease, and, apart from the fact that the endotheliomatous glands are originally harder and have no tendency towards breaking down, the comparison is excellent.

IV. REMOTE METASTASES.

Conclusions on this subject are only justifiable if one has at one's disposal the records of a large number of cases observed up to their conclusion and with post-mortem records. A few cases of malignant nasopharyngeal growths showing remote metastases are recorded in the literature of the subject,[7, 11, 12] but none of these cases, so far as I can judge, belonged to the endothelioma group. In my own series two cases showed evidence of remote metastases. One patient (Case 4) had, when last seen, eighteen months after the onset of the disease, a large mass in the liver, the mass having appeared within the space of a few months. The other patient (Case 2), when seen fourteen months after the onset, was suffering with pain in the back and legs, the distribution of which strongly suggested the presence of pressure on the spinal nerve roots in the lumbar region. The radiogram of the spine showed no definite evidence of growth and no collapse of the vertebræ, but I have very little doubt that a secondary growth was present.*

These two examples of secondary growths occurring in a series of five

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* Numerous general metastases were found at the post-mortem in this case.

cases, only four of which were observed in their terminal stages, suggest that the occurrence of remote metastases is fairly frequent. It does not, however, appear to be an early event in the history of the disease. It remains to be seen to what extent remote metastases would occur if the primary growth were eradicated by the use of radium.

V. THE EARLY SYMPTOMS OF THE GROWTH.

In judging the early symptoms of the growth, I have taken into consideration, in addition to the 5 cases which have come under my personal observation, 4 cases which were undoubted examples of the disease recorded in the case books of Mr. Bilton Pollard and Mr. Wilfred Trotter. Probably many more could have been found, but I have confined myself, in speaking of cases which have not come under my personal observation, to those which were undoubted examples of the condition in question and in which the notes are reasonably complete. Using these 9 cases, the initial symptoms were as follows: enlargement of the glands of the neck, 3 cases; pain in the distribution of the 5th nerve, 3 cases; deafness, 2 cases; hæmorrhage from the pharynx, 1 case.

It is interesting to note that in all three cases which showed pain in the distribution of the 5th nerve as an original symptom, attempts had been made to relieve the pain by extraction of teeth. In two cases teeth were extracted from the upper jaw, in the third the actual teeth extracted are not mentioned.

In order to give some idea of the frequency of the various symptoms and signs which I have mentioned, I have prepared a table (*Table I*, p. 252) showing the early signs in the 9 cases which I am here considering.

VI. THE MICROSCOPIC APPEARANCES OF THE GROWTH.

This is not a matter with which I propose to deal in detail: firstly, because I do not feel competent to deal arbitrarily with a matter in which pathologists find themselves at variance; and, secondly, because among the sections at my disposal the indifferent and poor greatly outnumber the good.

It does not appear to me to be of great importance whether the tumour is called an endothelioma or is grouped as a special form of carcinoma. The sections which I have at my disposal are derived from six of the nine cases I have quoted. All these sections both from the primary growths and from the glandular metastases show a sufficient number of points of similarity to justify their inclusion in a single group.

The growth at first sight strongly suggests a carcinoma, as it is composed of large irregular cells, mostly spheroidal, lying in groups which are separated by a considerable amount of connective tissue. Throughout the tumour there is no sign of degeneration and there are no cell nests. On closer inspection there is a very evident tendency for the cells to be arranged in relation to clear spaces which do not appear to be the result of degeneration. In some sections the spaces show as fairly large clefts, but a commoner appearance is for the cells to be arranged so as to form tubules, the diameter of which is only two or three times that of a single cell. This appearance is well shown in the microphotograph reproduced from the section of the tumour

Table I.—Frequency of the Cardinal Early Symptoms in Nine Cases of Endothelioma of the Nasopharynx.

CASE	ENLARGEMENT OF CERVICAL GLANDS	PAIN IN DISTRIBUTION OF 5TH NERVE	ANÆSTHESIA OR PARALYSIS IN DISTRIBUTION OF 5TH NERVE	SWELLING IN MOUTH*	TRISMUS	HÆMORRHAGE FROM NOSE OR PHARYNX	PALATAL PARALYSIS	UNILATERAL DEAFNESS	TIME SINCE ONSET	NOTES
1. F. G. Surgical Unit 1928	No	Yes Teeth extracted	Yes	No	Slight	Yes	Yes	Yes	3 months	—
2. J. M. Surgical Unit 1928	Yes	Yes	No	No	Yes	No	No	No	3 to 4 months	—
3. E. W. Mr. Williams 1925 and 1926	Yes	No	No	No	No	No	No	Yes	4 months	Notes state that palate was 'bulged down'
4. A. R. Mr. E. K. Martin 1926	No	Yes Teeth extracted	No	Yes	No	Yes	No	No.	15 months	—
5. H. B. Surgical Unit 1924	No	Yes Teeth extracted	No	Yes	No	No	No	No	6 weeks (probably more)	—
6. C. Mr. Trotter 1919	Yes	Yes	Paras-thesia	No	No	Yes	Yes	Yes	5 months	—
7. P. Mr. Pollard 1913	Yes	No	No	No	No	No	No	No	3 to 4 months	Notes state that palate was 'bulged'
8. J. Mr. Trotter 1911	No	No	No	No	No	Yes	No	No	5 months	Notes incomplete
9. B. Mr. Trotter 1912	Yes	Yes	No	No	Yes	No	No	Yes	2½ years	Discharge from ear
Total of Positive Cases	5	6	1	2	3	4	2	4		

* By swelling in the mouth I mean a swelling below the level of the palate which can be seen without post-nasal examination.
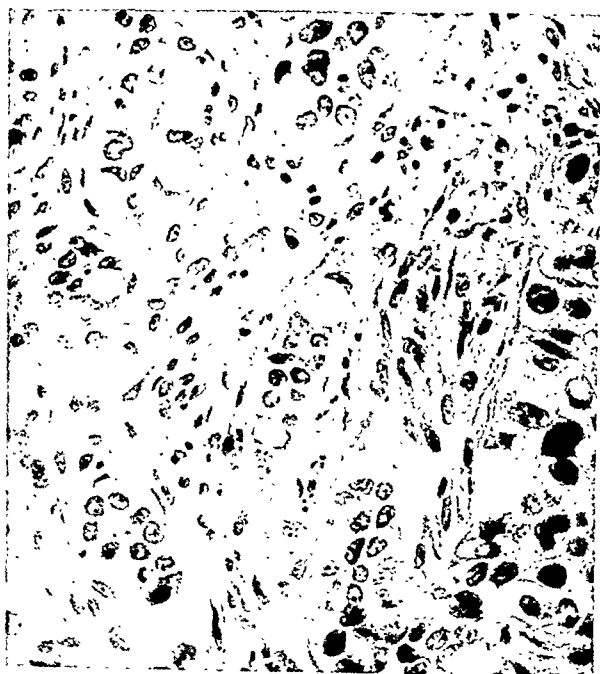
Fig. 156.—*Case 5.* The tubular arrangement of the cells is well seen, particularly in the centre of the figure, where a curved tubule has been divided transversely at both ends, the intermediate part of the section running through the wall of the tubule. ($\frac{1}{7}$ obj.)

Fig. 157.—Showing the general structure of the tumour and its tendency to submucous spread. ($\frac{2}{3}$ obj.)

taken from *Case 5* (*Fig.* 156). The section here has run through the curved part of a U-shaped tubule, dividing the tubule more or less transversely at both ends and running through its wall in the intermediate part. The arrangement is by no means as regular as this in all the sections or in all parts of the same section. In many places the shape of the cells can be seen to be adapted to the formation of a regular lumen. Another striking feature of the growth, which is in accord with its clinical behaviour, is that, however close the tumour substance approaches to the mucous membrane, it has no effect on it apart from what appears to be a pressure atrophy over the most prominent part of the growth. This peculiarity is well shown in *Fig.* 157, where the epithelium of the mucous membrane can be seen to be thinned by pressure to a marked degree without being actually invaded.

I am hopeful that in course of time, as these tumours become better recognized, it will be possible to discover the exact point of origin of the growth, and possibly in the hands of an expert pathologist the peculiar microscopic structure might furnish some clue.

VII. POSSIBLE LINES OF TREATMENT.

A very cursory consideration of the physical signs of these tumours will be sufficient to convince the majority òf surgeons of the futility of ordinary surgical methods as a means of treatment. Trotter has obtained a temporary *success in one of his cases, the patient being free from recurrence for eighteen* months. Considering the manner in which these tumours spread, and the situation in which they originate, such a result is sufficiently gratifying, but it cannot be said to be satisfactory. The only case in my own series in which the question of operability arose was *Case* 1, and in view of the fact that both the second and third divisions of the 5th nerve were involved it was not considered that an attempt at radical removal could be justified.

The question of treatment by radium has yet to be considered. *Cases* 2 and 3 of my series were treated with radium for the enlarged cervical glands, in both cases with some measure of success; *Case 3* is at the time of writing still under my observation, and the glands have progressed but little since the time at which I first saw him some nine months ago. The only cases in which a direct application of radium to the growth was tried are *Cases* 4 and 5, where little or no improvement followed. Here the growth had extended very widely before any treatment was attempted, and the irradiated part of the tumour can only have been the outlying margin of a very extensive mass. However, the fact that the glands can be kept in check by radium seems to show that radium has some influence on the tumour. The only line of treatment which appears to me to offer any hope at present is the insertion of seedling tubes of radium emanation in the directions in which we know the tumour to spread. This can, I think, be done only by exposing the tumour by means of Trotter's osteoplastic resection of the upper jaw; I have made one attempt at inserting radium without exposing the tumour, and was impressed by the obvious futility of the proceeding.

The outlook from the point of view of treatment is distinctly gloomy, but I should not now hesitate to use seedling radon tubes after exposing the

growth. As a purely palliative measure where the pain is severe an alcohol injection of the Gasserian ganglion may be tried. In the only case where I have done this there was a definite but transient relief.

CASE RECORDS.

The cases here recorded are those which have come under my personal observation. That the clinical observations in the earlier cases are not more complete is due to the fact that I did not at the time realize that they belonged to this group and consequently did not look for signs such as unilateral deafness. There is, however, in my opinion, sufficient evidence to justify grouping these five cases together as examples of endothelioma of the nasopharynx in its different stages and different aspects.

Case 1.—(Surgical Unit 4955, 1928). F. G., a man of 56, was admitted with a three months' history of pain in the left side of the face extending from the eye to the lower border of the mandible. Carious teeth had been removed without influencing the pain. During the three months the patient had noticed the onset of deafness on the left side and difficulty in opening his mouth. For one month there had been an occasional burning sensation on the left side of the tongue. A few days before admission he had a profuse hæmorrhage from his nose and mouth.

PHYSICAL SIGNS—A strong healthy-looking man. The speech suggested obstruction of the nose. There was pain in distribution of second and third divisions of the 5th nerve on left side ; paræsthesia and numbness in the distribution of the second division ; anæsthesia over area supplied by mental branch ; paralysis of muscles of mastication on left side. The soft palate was insensitive and immobile on left side, and there was deafness in the left ear. A hard sessile mass was palpable on the left lateral wall of the nasopharynx ; it extended down to the tonsil, and was not ulcerated. The X-ray showed erosion of the dorsum sellæ. There was no enlargement of glands in neck. No treatment was attempted.

FURTHER PROGRESS.—This was rapid, and five months after admission the patient was moribund from inanition following on paralysis of the pharyngeal muscles. There was also paralysis of the larynx, and the left sympathetic was involved. There were no obvious secondary deposits, no enlarged glands, and no signs of intracranial involvement.

REMARKS.—This case may be taken as typical of the condition, apart from the absence of glandular involvement.

Case 2.—(Surgical Unit 4808 and 4939, 1928). J. M., a man of 29, had had swelling in left side of neck for three or four months, stiffness of the jaw for five or six weeks, aching pain in gums of left side for two weeks.

ON EXAMINATION.—He was fairly well nourished. There was marked trismus. Typical 'endotheliomatous' glands were noted in the left deep cervical group and one large gland on right side. No anæsthesia in distribution of the 5th nerve. X rays showed a wisdom tooth lying horizontally in the lower jaw on the left side. The nasopharynx was not examined, owing to trismus.

TREATMENT.—The wisdom tooth was removed, and a gland excised for section. Subsequently numerous applications of radium were made to the glands in the neck, and an alcohol injection of the Gasserian ganglion was attempted for relief of pain. This was temporarily successful.

MICROSCOPIC SECTION of the gland shows a typical endothelioma.

PROGRESS.—Nine months after the onset a firm submucous swelling appeared at the junction of the hard and soft palate on the left side. A month later a mass appeared filling up the left temporal fossa (*see Fig.* 155). There was then a left external rectus palsy and anæsthesia over the distribution of the mental branch of the trigeminal. The patient complained of a discharge from the left ear and

deafness. No palatal paralysis. The glands had increased somewhat in size, but were kept in check by applications of radium. His general nourishment remained good.

Five months later, and fourteen months after the onset of the disease, this patient was readmitted in a very wasted condition. The 6th-nerve paralysis had then disappeared and subsequently varied in degree from day to day, but the left pupil showed a deficient reaction to light and accommodation, presumably as a result of a partial paralysis of the 3rd nerve. The patient also complained of dimness of vision in the left eye, and this eye subsequently became almost blind. There was nothing to suggest the presence of growth in the orbit, and on examination of the optic disc there was no optic neuritis. There was some difficulty in swallowing, which appeared to be due neither to pain nor to mechanical obstruction. Headache was absent, and the pain in the face was still strictly limited to the left side.

The glands had increased greatly in size during the previous month, and the patient complained of pain in the lumbar spine, girdle pain, and pain in the front of the legs. There was no deformity of the spine, and X rays failed to show any definite evidence of invasion of the lumbar vertebrae.

The patient gradually became weaker, and died, about sixteen months after the onset of the disease, from pneumonia.

POST-MORTEM EXAMINATION.—Thanks to the skill of Dr. Barnard, who performed the post-mortem examination and removed the specimen, I was able to examine the relation of the growth to the base of the skull in some detail. The specimen as it came to me consisted of a large portion of the central part of the base of the skull, together with the maxillæ and nasal cavities, the pharynx, tongue, larynx, and the great vessels of the neck.

From this specimen I removed the basiocciput, and the body and small wings of the sphenoid bone. The bone here showed no sign of invasion by growth, and both the sphenoidal sinus and the pituitary fossa were free from involvement. The remaining portions of the great wing of the sphenoid were removed piecemeal to permit of tracing the branches of the 5th nerve into the growth. The growth was firmly attached to the bone in the neighbourhood of the foramen ovale, and the bone here appeared to have been eroded. The microscopic section of the bone, however, showed no actual invasion by growth. The specimen was then bisected in a sagittal plane, leaving the inner end of the petrous part of the temporal bone *in situ* on both sides.

On examining the specimen from inside the pharynx there is no ulceration of the mucous membrane. The left Eustachian orifice is obscured by a submucous swelling, and the whole lumen of the nasopharynx on the left side is diminished, although the pharynx is held permanently open by the rigidity of its walls on the left side, giving the lumen, in cross-section, a wedge-shaped appearance with the base of the wedge to the left. Examination of the divided wall of the pharynx shows that its roof is infiltrated with growth, as also is the soft palate. The growth has not extended forward so as to obstruct the nasal choanæ.

Examination from outside shows a mass of growth on the left lateral wall of the pharynx, continuous below with a glandular mass which surrounds the great vessels of the neck. The mass occupies the pterygoid region and, extending forward, has completely filled the maxillary antrum, encircling and destroying the pterygoid plates and the posterior wall of the antrum. The growth partially encircles the ramus of the lower jaw.

On the roof of the pharynx, in the situation from which the basisphenoid has been removed, is a mass of growth more than a centimetre in thickness in its hardened state. It extends across the middle line as far as the right foramen ovale.

The sole intracranial spread of the tumour is by way of the carotid canal. On the left side the carotid artery is embedded in a process of the growth which extends up into the interior of the skull, but apparently stops short of the cavernous sinus. The left 6th nerve as it passes over the lip of the petrous temporal enters this process of growth. The same process of growth turns outwards over the petrous

temporal and runs beneath the Gasserian ganglion. The first and second divisions of the 5th nerve pass forward without being obviously involved in the growth, but the third division passes downwards through the foramen ovale into a mass of growth outside the skull.

The 4th and 3rd nerves can be traced in the cavernous sinus and are apparently free from growth, although they are less easy to trace than on the right side. There is no macroscopic involvement of the optic nerve.

The carotid artery is not thrombosed. The whole extent of the intracranial growth is not greater than that of the Gasserian ganglion. On the right side the growth has invaded the lower end of the carotid canal, but has not reached the interior of the skull and has not involved the 6th nerve.

Metastases having the same macroscopic appearance as the primary growth were found in several ribs, in the spine, and in the left lobe of the liver.

The macroscopic evidence suggests that the 6th nerve and the third and second divisions of the 5th nerve were involved directly in the growth. The cause of the disturbance of the function of the oculomotor and optic nerves is less obvious, but was in all probability an interference with their blood-supply. In the earlier stages this was probably true also of the 6th nerve, as the loss of function was temporary at first and tended to vary in degree for some time.

Microscopic sections were made of the optic nerve proximal to the orbit, and of the 3rd nerve and the first and second divisions of the 5th in the cavernous sinus. The optic nerve showed no invasion by growth and was not degenerated at the point where the section was made ; hence the involvement was probably posterior to the section, i.e., intracranial and not intra-orbital. The sections of the 3rd nerve and the first and second divisions of the 5th, taken from these nerves in the cavernous sinus, showed no growth.

The post-mortem is interesting mainly in showing the small extent of the intra-cranial spread in relation to the size of the extracranial mass, and in demonstrating that clinical signs of interference with the function of the nerves running in the cavernous sinus may be present before the growth has actually reached the nerves in question.

REMARKS.—The nasopharynx was never examined in this case owing to the trismus. The symptoms and the microscopic appearances, in association with the appearance of the swelling in the mouth, left no doubt as to the nature of the tumour. Radium was temporarily successful in keeping the progress in the glands in check.

Case 3.—(Mr. Gwynne Williams, 4611, 1925, and 834, 1926.) E. W., a woman of 44, had complained of lumps in the left side of the neck for four months, and similar lumps on the right side for one month. Previous to this she had become deaf in the left ear.

ON EXAMINATION.—She was fairly well nourished. There were typical 'endo-theliomatous' glands on both sides of the neck, and by the mouth was a hard mass which bulged down the soft palate and could be felt on the left lateral wall of the nasopharynx. She had no pain except on palpation of the glands.

MICROSCOPIC SECTION OF TUMOUR.—Endothelioma.

TREATMENT.—Radium was inserted into the glands and the primary tumour.

PROGRESS.—The glands diminished in size. Two months after the first application an external rectus palsy appeared on the left side. A further application of radium was made to the glands. The patient was not seen again.

REMARKS.—These tumours are unusual in women. The absence of pain is a remarkable feature. On her second admission the patient complained of loss of voice, which may have been due to a commencing laryngeal paralysis.

Case 4.—(Mr. E. K. Martin, 2936 and 3855, 1928.) A. R., male, age 58, fifteen months previous to admission had a copious hæmorrhage from his mouth which lasted for one night. Previous to this he had had 'toothache' for which some teeth had been extracted. He was then fairly well for a year, after which a recurrence of the toothache was followed by a further hæmorrhage.

PHYSICAL SIGNS.—A pale but well-nourished man. There is a firm submucous swelling extending forward from the junction of the hard and soft palate to the incisor region. The palatal swelling is more marked on the left side, and there is a visible swelling of the face over the left maxilla. There are no enlarged glands in the neck. There is some nasal obstruction, which the patient believes to be more marked on the left side.

MICROSCOPIC SECTION OF TUMOUR.—Endothelioma.

TREATMENT.—Radium was applied to the accessible parts of the tumour without producing any marked improvement.

PROGRESS.—Three months later the patient was readmitted. He was then obviously wasted. The tumour had increased in size by a further submucous extension, so that the upper jaw and alveolus on both sides were enormously enlarged. There was an ulcer at the junction of the hard and soft palate on the left side. There was a large mass in the liver. A further application of radium produced no beneficial result.

REMARKS.—There is perhaps some doubt as to whether this case is rightly included in the series. There was, however, a long period between the onset of symptoms referable to the presence of a tumour and the appearance of the tumour in the mouth. When the growth did appear it was in the typical situation and showed the typical submucous spread. Microscopically it coincided with those of the other cases in the series. In combination with the presence of 'toothache' as an original symptom, these facts appear to me to mark this case as an endothelioma of the nasopharynx.

Case 5.—(Surgical Unit 2590 and 2710, 1924.) H. B., a man of 59, was admitted complaining of pain in the right upper and lower jaw, following extraction of carious teeth, and swelling of the face. The teeth had been removed six weeks before admission. He was a thin man. There was a visible swelling of the right side of the face. A week later a submucous swelling appeared at the junction of the hard and soft palate on the right side. Six weeks later there was a large swelling in the mouth on the right side, extending over the alveolus. The mass was superficially ulcerated. The palate on the right side was pushed down and immobile, and the uvula was pushed over to the left. The right temporal fossa was filled up by a mass beneath the deep fascia, producing an obvious deformity of the face. There were no enlarged glands in the neck.

MICROSCOPIC SECTION.—Endothelioma (see Fig. 156).

TREATMENT.—Radium was inserted into the accessible part of the tumour. This produced a very temporary improvement, and the patient was shortly afterwards transferred to an infirmary.

REMARKS.—I think there can be no doubt that this case belongs to the group of tumours in question. The onset with pain in the distribution of the 5th nerve, the site of appearance and submucous character of the tumour in the mouth, and the microscopic appearance of the tumour, are sufficient to justify its inclusion. In addition to these points, the extension of the tumour into the temporal fossa took place in exactly the same manner as that in Case 2. There are no observations as to deafness and anæsthesia in the distribution of the 5th nerve, as I saw the case before I was familiar with the numerous and diverse manifestations of these tumours, and did not at the time realize that this case belonged to the group.

LITERATURE OF THE SUBJECT.

For several reasons I have thought it advisable to devote a separate section of this article to a review of the literature of the subject. Reports of malignant tumours of the nasopharynx showing involvement of the nervous system are fairly numerous, but as a result of the diversity of the symptoms, cases have been reported by neurologists, laryngologists, pathologists, and ophthalmologists, and naturally each specialist has tended to dwell on the

aspects of the case most interesting to himself. It is clear that many of the reported cases belong to the group which I have attempted to describe, but often examples of other forms of tumour are included under the same heading. A further difficulty is introduced by the fact that there is no uniformity of opinion as to the interpretation of the microscopic appearances of the endothelioma, and it is usually impossible to gather from the reports of microscopic examination whether or not a particular reported case belongs to this group. In a few cases clinical peculiarities of the tumour sufficient to place it are mentioned, but more often one finds the unadorned statement that a tumour was present in the nasopharynx.

The term 'endothelioma' is admittedly more or less properly applied to 'mixed' or 'salivary' tumours, and some reported cases of endotheliomata in the pharyngeal region are clearly examples of these tumours, which are met with fairly frequently in the palate.[8] They possess no points in common with the endothelioma of the nasopharynx beyond their somewhat unfortunate name.

The earliest reference which I have consulted is a long article published in 1907 by Harmer and Glas.[9] This article is concerned mainly with tumours originating within the nasal cavity, sometimes invading the cranial cavity through the cribriform plate, and the orbit in the neighbourhood of the lamina papyracea. These tumours are naturally liable to be associated with invasion of the first four cranial nerves, and may also give rise to neuralgic pain. The pain, however, is often in the distribution of the first division of the trigeminal nerve, sometimes in that of the second division, and (as far as I am able to judge from the literature) never in that of the third. Moreover, tumours of this type are liable to be associated quite early in their course with proptosis, which is due to actual filling up of the orbit with growth, and with definite symptoms pointing to a nasal origin, such as epistaxis and nasal obstruction. The pain appears to be due in many cases to obstruction of the outlet of the frontal sinus or the maxillary antrum, and suppuration may arise in these cavities from the same cause. Naturally these tumours do not often come under the care of a general surgeon, and, consequently, my knowledge of them is gathered almost entirely from the literature of the subject. It appears certain to me that much of the difficulty which one encounters in attempting to form a clear conception of malignant tumours of the nasopharynx from lists of reported cases is due to the fact that usually no distinction is made between these growths, which are primarily tumours of the nasal cavity with a tendency to secondary involvement of the first four cranial nerves, and the group I have described, which consists of tumours which are really infiltrating growths at the base of the skull accessible to the examining finger in the nasopharynx. Perhaps the most useful distinction is the presence of proptosis in a number of cases of the intranasal type. Harmer and Glas do not classify any of the tumours in their report as endotheliomata, but there was at the time a considerable controversy in Germany as to the characteristics of an endotheliomatous tumour, and the literature of the time tends to place the incidence of the endothelioma very high or very low according to the views of the writer. However, allowing for this point, I have been unable to satisfy myself that any one of the tumours mentioned in this paper belonged to the group which I have described.

A somewhat later article by Pollak,[10] published in 1911, deals almost exclusively with the pathological side of the question, and places the incidence of endotheliomata very much higher.

In 1911, in a paper read before the Medical Society of London, Trotter[1] gave a short account of the tumours with which I am dealing, and it was this paper which first attracted the interest of the present writer to the condition.

Several papers of later date are devoted to an account of nasopharyngeal tumours which have given rise to symptoms of interference with the nervous system, still, however, without any very successful attempt to differentiate the various types. The most valuable of these papers is one published in Chicago in 1922 by H. W. Woltman.[11] In it are reported 25 cases of naso-pharyngeal tumours with involvement of the cranial nerves; 15 of these are stated to have been squamous epitheliomata and 6 lymphosarcomata. A list of the nerves which were found to be involved in these 25 cases is, I think, worth quoting fully (*Table II*).

Table II.—Showing the Proportions in which the Cranial Nerves were Involved in 25 Cases of Nasopharyngeal Tumour Reported by H. W. Woltman.

Cranial Nerve	Epitheliomata	All Cases
I	Not determinable	
II	1 in 15	5 in 25
III	2 ,, 15	4 ,, 25
IV	2 ,, 15	4 ,, 25
V Sensory	6 ,, 15	11 ,, 25
V Motor	4 ,, 15	6 ,, 25
VII	1 ,, 15	1 ,, 25
VIII	Not determinable	
Palate	4 in 15	6 in 25
Vocal cords	1 ,, 15	3 ,, 25
XI Spinal	1 ,, 15	3 ,, 25
XII	4 ,, 15	5 ,, 25

In addition to the author's 25 cases a list of cases from the previous literature is given. Some of these tumours belong certainly to the group which I have described; others certainly do not. On the whole, those described as squamous epitheliomata bear a closer resemblance to my cases, and in one of these it is mentioned that in the later stages a swelling appeared in the temporal fossa, presumably of the same nature as that described in *Cases* 2 and 5 of my series.

As regards the question of remote metastases, these were present in one of this author's cases and in three of those which he has collected from the literature. None of these can be said with any certainty to belong to the endothelioma group. Other interesting points are made in this article, particularly that of the possibility of confusion of a malignant nasopharyngeal tumour showing X-ray evidence of destruction of the sella turcica with a pituitary tumour; and that of the varying degree to which the sensations of pain,

touch, and temperature are lost when the 5th nerve is involved in the growth of the tumour.

New,[5] dealing also with the recent cases from the Mayo Clinic, emphasizes the frequency with which patients suffering from malignant nasopharyngeal tumours are submitted to operations such as extraction of teeth or tonsils, in the hope of relieving pain the true cause of which has not been diagnosed.

Crow and Baylor[12] are concerned less with the neurological aspects of the cases than with the treatment by radium. In their article the cases grouped as carcinoma include many which correspond closely to those which I have described. Over one-third of these cases had signs of gross intracranial invasion before death, 13 of 15 had glandular involvement, and 9 had marked trismus. The earliest symptom was pain in the ear or loss of hearing in 7 cases, and glandular enlargement in 3. On the whole, the patients are younger than those of my series, the average age of the 15 cases being about 32. Paralysis of the palate is mentioned in several instances. Radium was used sometimes in the treatment of patients in this group, but no cures are recorded, although a temporary improvement was occasionally produced.

Two interesting cases are excellently reported from the point of view of the ophthalmologist by Stähli, of Zurich.[13] The first of these showed a 6th-nerve palsy as the sole symptom of the condition for a period as long as five months; the second was first seen complaining of a 3rd-nerve palsy. It is possible that the second case was an example of the intranasal type of growth rather than the infiltrating endothelioma. This author has noted the very interesting point that in both these cases the degree of paralysis after the onset was inconstant, and even complete recovery took place for short periods.

There remains to be considered the modern French literature on the subject.

M. Jacod, of Lyons,[14] recognizes the type of growth which I have described, and speaks of it as a 'peritubular sarcoma'. He has devoted much attention to the intracranial spread of these tumours, which he believes to take place through the bony part of the Eustachian tube, whence it is directed forwards into the middle fossa of the skull, rather than backward into the posterior fossa, by reason of the relative thickness of the bone in these two directions. According to Jacod the cranial nerves are involved within the skull at a point which he speaks of as the 'carrefour pétrosphénoïdal—that is, the situation at which the antero-internal end of the petrous temporal comes into contact with the great wing of the sphenoid. Here the first six cranial nerves are placed in close apposition to one another, and may be involved by a comparatively small growth. M. Jacod states that in the peritubular sarcoma the first six cranial nerves are invariably attacked sooner or later, while those which leave the skull in the posterior fossa are never involved. Paralysis of the sympathetic has been noted by him, and he holds that invasion of this nerve occurs in the cavernous sinus.

In my own experience, and in the experience of other authors whose work I have quoted, the nervous signs are by no means as regular as this, and the invasion is definitely not confined to the first six cranial nerves. Neither is invasion of the 2nd, 3rd, and 4th nerves by any means frequent. One only of my cases showed involvement of these nerves, and the proportion in the

'epitheliomata' reported by Woltman is strikingly low.   An isolated 6th-nerve paralysis produced by intracranial invasion arouses no surprise, but a prolonged and isolated involvement of one or two parts only of the 5th nerve suggests much more strongly an extracranial invasion.   One would have expected also that a growth so accurately localized at the 'carrefour pétrosphénoïdal' would, in a proportion of cases, give rise to a thrombosis of the cavernous sinus. There is no mention of this event in any of the articles which I have consulted. The invasion of the sympathetic has been held by some authors to be due to glandular metastases, but I think this theory is untenable, as in one of my own cases there was a sympathetic paralysis although no enlarged glands could be felt in the neck.   Most probably, I think, it occurs before the sympathetic comes into relation with the cavernous sinus.

In the article by M. Jacod referred to above, two cases are quoted.   I believe the same author made a previous communication on the subject in the year 1920, but this I have been unable to trace.

Reverchon[6] reports fully two cases, giving in one of them a record of the post-mortem examination.   At the post-mortem of this case a mass of growth was found covered by intact dura mater in the middle fossa behind the great wing of the sphenoid.   Growth had invaded the sphenoidal sinus, and outside the skull it occupied " all the recesses of the surrounding regions ".   The second case is mainly remarkable for the fact that in the early stages there was a transient attack of herpes zoster in the distribution of the 5th nerve on the side of the tumour.   In both these cases Reverchon refers to ' phénomènes d'hypertension ' which in the first case were relieved by lumbar puncture and in the second by a subtemporal decompression.   Treatment by radium met with some success in both cases ; indeed, it is recorded of the second that after a year of treatment the weight of the patient had increased by 5 kilo. M. Monod, of the Radium Institute, is quoted as giving the following opinion as regards treatment by radium :   " Il est vain d'essayer dans un cas semblable, d'atteindre tous les prolongements par la radiopuncture.   Si le traitement par le radium est indiqué il faut avoir recours à des appareils moulés recouvrant complètement la région à irradier."   An apparatus covering practically the whole of one side of the face and temporal regions would thus be necessary, and a sufficient quantity of radium would be required to irradiate adequately the whole of this region in one application.   I speak without experience of this form of irradiation, but I believe that in the present state of our knowledge of the technique of irradiation the difficulties would be very considerable both in attaining a sufficient concentration at a situation so far from the surface and in avoiding damage to normal structures.

The opinion of M. Monod in this matter is, of course, entitled to the very greatest respect.   Nevertheless, provided that the presence of the tumour is recognized at a reasonably early period and that the region concerned is adequately exposed by a well-planned operation, I think that there are good prospects of success in treatment by implantation of radium emanation. Naturally success in treatment by implantation depends on an accurate knowledge on the part of the surgeon of the directions in which the tumour ordinarily spreads, and I hope that my article will be found of use in attaining this knowledge.

SUMMARY.

1. An account is given of the clinical characteristics of a tumour usually described as an endothelioma of the nasopharynx. The variability of the clinical picture presented by these tumours is emphasized.

2. It is suggested that tumours of this type are by no means uncommon, and that many of them pass unrecognized because of the absence of obvious symptoms pointing to a nasopharyngeal origin, and because the presence of a tumour is only recognized when the condition is sufficiently far advanced to render the primary origin of the growth a matter of conjecture, and of purely theoretical interest.

3. It is emphasized that there is some evidence to show that endotheliomata in this region react favourably to radium except when it is applied only to the outlying parts of an extensive tumour, and it is suggested that good results might be obtained by a combination of adequate exposure of the growth with irradiation by means of seedling tubes of radium implanted in the directions in which the tumour is known to extend.

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TWO CASES OF RIEDEL'S CHRONIC THYROIDITIS.

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IN view of the rarity of this condition it has been thought worth while to add two more to the number of published cases. A. F. Bernard Shaw and R. P. Smith[1] reported on six cases, and gave a review of the literature, in the BRITISH JOURNAL OF SURGERY in 1925. Both the following cases bear a close resemblance to the earlier ones of their series, or to what used to be termed Hashimoto's struma lymphomatosa. As has so often happened, the diagnosis was only made microscopically, and in the first case with considerable difficulty.

Case 1.—The patient, a woman of 46, was transferred from the medical wards with a marked enlargement of the thyroid gland involving mainly the right lobe, which was smooth and very firm in consistence. She gave a history of a swelling in the neck of six years' duration, with a fairly rapid increase in

FIG. 158.—*Case* 1. Showing two lymph follicles and acini amongst the granuloma. (× 100.)

size during the last three months. Her complaint was of slight dyspnœa, occasional hoarseness, and occasional palpitation, especially on exertion. She stated that she was easily tired, but her general health seemed good, although she showed signs of slight thyroid deficiency. There was no evidence of tuberculosis, and the Wassermann reaction was negative. The pulse-rate

was 80 per minute. The condition was thought to be a parenchymatous goitre, but the question of malignancy was considered owing to the unusual hardness of the gland.

OPERATION.—The right lobe and isthmus of the thyroid were removed with some difficulty owing to adhesions to the surrounding structures. There was some thickening of the capsule. The cut surface of the gland was finely lobulated, opaque, and solid looking, and seemed entirely devoid of colloid.

The patient was seen recently, two and a half years after operation. A definite thyroid deficiency had been counteracted by the administration of thyroid extract, and she is now feeling very well. There has been no recurrence of the swelling, and the left lobe of the thyroid has gradually decreased in size.

HISTOLOGY. — The capsule and interlobular septa are all infiltrated with mononuclear cells. The vessels are scanty and of normal thickness. The appearances in different places vary considerably. In some parts, presumably where the disease is more advanced, hyaline stroma forms a coarse reticulum enclosing comparatively few cells and no acini. Other parts show a very cellular granuloma, with a minimal amount of stroma and enormous numbers of plasma cells, lymphocytes, and a few fibroblasts. In some of these areas acini are present in considerable numbers. Some contain a small amount of colloid. Where acini are unrecog-

FIG. 159.—Case 1. An acinus is seen to the right of the centre containing a foreign-body giant cell and phagocytes. To the left is an acinus containing colloid which is undergoing phagocytosis. (× 200.)

nizable high-power examination sometimes reveals the remains of epithelial cells, many invaded by leucocytes or plasma cells which are apparently acting as phagocytes.

The most striking feature in all the sections examined is the presence of very definite and well-formed lymph follicles (Fig. 158). These vary in size, and are round or oval in shape. Each germ centre is surrounded by a definite zone of lymphocytes which varies in thickness and is limited by a delicate stroma containing capillaries. Among the cells of the follicle a considerable amount of irregular hyaline material is seen. The majority of the cells are large and round with vesicular nuclei, but lymphocytes and fibroblasts are also present. These follicles are to be found throughout the sections.

Another notable feature is the number of giant cells to be seen with a low power (*Fig.* 159). They are unevenly distributed and are not associated with the lymph follicles. With a higher power many of these are found to be masses of colloid invaded by phagocytic cells which are at times arranged in a circle. These masses are usually to be seen within acini. The most striking of the real giant cells are strongly suggestive of tubercle, and are, in our opinion, foreign-body giant cells. They are commonly embedded in degenerating acini, their cytoplasm being readily distinguishable from that of the epithelium by slight differences in texture and staining. The nuclei are smaller than those of the epithelium and they are arranged in characteristic groups. As already mentioned, the acini may also show invasion by plasma cells. In places these giant cells are actually within acini, but we could find no evidence that they were derived from the epithelium, although a multinucleate condition of the epithelial cells may occasionally be seen.

Case 2.—The patient, a woman of 34, gave a history of a swelling in the neck of five years' duration, associated for the last year with severe attacks of dyspnœa which had caused her to seek advice. The right lobe and isthmus of the thyroid were enlarged, the swelling being smooth and apparently cystic. She showed signs of slight hyperthyroidism, but the pulse-rate was only 86 per minute. The Wassermann reaction was negative.

OPERATION.—Although but slightly enlarged, the right lobe of the thyroid was removed with great difficulty owing to adhesions to surrounding structures, particularly the trachea. The cut surface of the isthmus was normal in appearance, while that of the right lobe was of an opaque white colour broken in places by vascular strands and studded with yellowish areas of colloid.

HISTOLOGY.—There is much thickening and cellular infiltration of the capsule and interlobular septa and some sclerosis of the blood-vessels. The typical granuloma with large numbers of lymph follicles and very marked fibrosis composes most of the gland, but, in striking contrast to the first case, there are areas of comparatively normal acini. Some contain colloid and others show absorption of colloid and definite signs of activity. Here also masses of colloid can be seen invaded by phagocytic cells, but the foreign-body giant cells are very scanty.

Both these cases appear to be examples of Riedel's chronic thyroiditis. Histologically the lesion in the first is at an earlier stage. Although the gland parenchyma is much more extensively destroyed, the granuloma is more cellular and there is less fibrosis than in the second case.

While differing in our interpretation of the giant cells, we agree with Bernard Shaw and Smith that the lymph follicles represent hyperplasia of the minute lymphatic nodes to be found in so many organs, and that the true nature of the condition is that of a non-tuberculous granuloma.

I have to thank Mr. Kay, Mr. Milne McIntyre, and Professor John H. Teacher for permission to publish, and Professor Teacher for the photographs and for much helpful criticism.

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REPORT OF A CASE OF ANEURYSM OF THE SPLENIC ARTERY:

WITH REFERENCES TO 58 CASES COLLECTED BY THE AUTHORS.

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ANEURYSMS of the branches of the abdominal aorta have been looked upon as pathological rarities, but there have been so many instances recorded recently that their recognition as a cause of clinical symptoms becomes of increasing importance. In 1928 Thomson[1] was able to collect 65 cases of aneurysm of the hepatic artery, and Senger[2] 40 cases of aneurysm of the renal artery. We have been able to find in the literature 58 cases of aneurysm of the splenic artery.

CASE REPORT.

Mrs. M., age 49, was admitted on Dec. 17, 1926, at 11 p.m., suffering from agonizing pain in the abdomen of seven hours' duration.

PREVIOUS HISTORY.—The patient was too ill to give a detailed history, but her husband said that for some years she had suffered from 'indigestion' —pain and discomfort coming on three to three and a half hours after meals, and occasional sickness and vomiting. There was no history of hæmatemesis or of melæna. She was indefinite about her menstrual history—thought the last period was two weeks ago, but stated that for some time there had been irregularity.

PRESENT ILLNESS.—About 4 p.m. on the day of admission the pain came on suddenly, and she collapsed but did not become unconscious. She vomited a little, but did not notice the nature of the vomitus. The agonizing pain continued till the time of her admission.

ON EXAMINATION.—Patient was anæmic and collapsed; temperature 98°, pulse 126, respirations 24. The abdomen was somewhat distended, tender all over, but with no muscular rigidity. Liver dullness was present, and ? dullness in both flanks. Pelvic examination was negative. No gross lesion of heart and lungs was made out. The provisional diagnosis was intraperitoneal hæmorrhage; ? ectopic gestation.

Operation (W. A.).—A right paracentral incision was made. A large quantity of fluid blood escaped from the peritoneal cavity, and a few soft blood-clots were removed from the pelvis. Examination of the pelvic organs showed the uterus to be slightly larger than normal, and the extremity of

the left Fallopian tube to be somewhat patulous. A rapid examination of the rest of the abdomen did not reveal any gross abnormality. Thinking I was dealing with a left tubal abortion I quickly removed the outer half of the tube and closed the abdomen. A pint of normal saline was given intravenously.

Convalescence was somewhat stormy for five days, the temperature being as high as 102° the day following operation, but thereafter the patient did well and was almost ready to leave hospital. On Jan. 4 she was reading in bed when she asked for a bed-pan ; before it could be brought she collapsed and died within twenty minutes. The symptoms suggested a pulmonary embolism.

Professor Low, Anatomy Department, Aberdeen University, kindly undertook the examination of the Fallopian tube, but careful serial section study failed to reveal any evidence of pregnancy.

Post-mortem Examination (J. G.).—The body was very pale. The greater sac of the peritoneal cavity contained a large amount of blood-clot and fluid blood of evidently recent origin. The lesser sac also was distended with blood. Some of this was fluid blood or recent clot similar to that in the greater sac, but there was a thick, shaggy layer of older clot adherent to the wall of the lesser sac throughout. At one point on the posterior wall there was an irregularly rounded crater-like depression in this layer of older clot, and that point was found to lie immediately over a saccular aneurysm of the splenic artery. A small chink-like opening in the wall of the aneurysm communicated with the lesser sac at this site. It was evident that two hæmorrhages had occurred from the aneurysm at different dates.

The first hæmorrhage, which, from the history, had evidently immediately preceded the operation, marked the time of the initial rupture of the aneurysm into the lesser sac. Hæmorrhage had at that time extended from the lesser sac through the foramen of Winslow into the greater sac, and accounted for the blood found there at operation. Such of the blood in the greater sac as had not been removed at operation was apparently absorbed subsequently. Much of the blood in the lesser sac had, however, remained, and formed the older, more adherent clot just described there. This clotting temporarily closed the opening in the aneurysmal wall.

The second and fatal hæmorrhage, occurring eighteen days after, burst through the same opening in the aneurysm into the lesser sac, ploughing up the older clot on the wall of the sac and passing by way of the foramen of Winslow to the greater sac.

The aneurysm itself was a 'false' aneurysm, a rather rough-walled sac forming a more or less rounded cavity about the size of a cherry lying in the substance of the pancreas. It opened from the main splenic artery by a narrow gap about half an inch long on the antero-inferior aspect of that artery at a point just outside the hilus of the spleen.

To the naked eye there was no atheroma of the splenic artery or of the main trunk of the cœliac axis. There was a small amount of blood-clot around the pancreas. The uterus and the uterine appendages on the right side were healthy. Beyond marked anæmia there were no important alterations in other organs.

MICROSCOPIC EXAMINATION.—

Splenic Artery Proximal to the Site of the Aneurysm.—The outer half of the media appeared to be almost normal. The inner half, however, showed extensive partial necrosis of the muscle fibres, the muscle nuclei being broken up or greatly distorted where they had not actually disappeared. A rather surprising feature was the practical absence of accompanying cellular infiltration, only a few small round cells being visible in the patches. There was no vascularization or evidence of increase of connective tissue. The elastic tissue of the degenerated part of the media was granular and was demonstrated with difficulty. Some fibrin was present. The intima was not thickened, and nothing abnormal was noted in the adventitia save perhaps a slightly increased cellularity (small round cells).

Splenic Artery at the Opening into the Aneurysm.—Sections were made showing the ruptured splenic artery opening into the aneurysmal sac. The wall of the artery here showed more marked disease than that just described in the wall nearer the commencement of the artery, but the changes appeared to be of the same type.

The only coat affected around the whole circumference was the media, and here, as before, the more marked alterations were in its inner half. All round, the inner half showed extensive necrosis of the muscle fibres with karyorrhexis of the muscle nuclei which survived. There was more round-celled infiltration in this zone than in the corresponding zone in the previous sections, but it was not very marked. There was no definite vascularization or increase of connective tissue. The outer half of the media showed an extensive patchy loss of individual fibres and groups of fibres, granular fibrinous débris alone surviving in such patches.

The intima was not thickened all round, and in particular it was not altered at the point of connection with the aneurysm (on the side investigated). It showed, however, considerable cellular thickening in part of the circumference. In this part, the internal elastic lamina, which had been running close to the endothelium, suddenly passed outwards for a short distance, to disappear abruptly. The thickened intima here was composed of cellular connective tissue, the cells being mainly fibroblasts with some small round cells. A few capillaries were visible.

There was no fatty change in either intima or media save for a very fine dusting of the internal elastic lamina. There was extensive fibrosis of the surrounding pancreatic tissue, but no cellular infiltration of the adventitia.

The opening into the aneurysm was next studied. The vessel wall approaching this point showed an unthickened intima but a very extensive necrosis of the media, leaving only a narrow surviving band of relatively healthy muscle in its outer part. Opposite the aneurysmal opening this wisp of media stopped abruptly, a small hæmorrhage marking the site of its termination in some sections. Shortly afterwards the internal elastic lamina and endothelium stopped also, and finally the adventitia with its thin layer of elastic tissue disappeared. Beyond this no semblance of arterial wall persisted. The aneurysmal wall was formed of concentric layers of fibrosed pancreas, with an inner lining of adherent thrombus.

In certain other sections cutting through the opening of the artery into the aneurysm at a different point, the external and internal elastic laminæ both persisted, one on either side of the degenerated media, right up to where the aneurysm commenced ; the media then thinned out and stopped, and as it did so the laminæ approached one another, almost joining where the media stopped. Here the internal elastic lamina stopped abruptly, but the external elastic lamina continued as a few faint strands in the adventitial tissue for a little into the wall of the aneurysm (*Fig.* 160).

FIG. 160.—Opening into aneurysm. Wall of splenic artery to left, internal and external elastic laminæ converging from left to right, forming a triangle.

Discussion of Microscopic Appearances.—It seems clear that the medial degeneration and necrosis were the primary and chief factors leading to the formation of the aneurysm. The thickened intima found in parts is apparently secondary, representing an attempt to strengthen the weakened wall, and it may be noted that rupture occurred at a point where this thickening had not taken place. The process seems to have been of fairly recent origin, but the paucity of cellular infiltration is peculiar.

There is evidently no relation to atheroma or other generalized arterial disease. The appearances do not suggest syphilis. They do, however, suggest a subacute infection.

COMMENTS ON CASES.

This unfortunate experience induced us to look up the literature, and we were struck by our ignorance of the number of recorded cases. In the accompanying table (*see* p. 272) the chief features of 58 cases are summarized.

Etiology.—A study of these cases does not show any outstanding causative factor. Septic emboli, arteriosclerosis, and syphilis have been suggested, but in a number of instances all of these can be definitely excluded. A Wassermann reaction was not done in our case, but the family history did not suggest syphilis, nor did post-mortem examination reveal any stigmata of this disease. No history of a previous septic focus could be obtained, nor was one found post mortem. Direct or indirect trauma has been suggested as a cause in a few cases. There was no history of this in the present case, although the patient had lived a strenuous life as the wife of a small farmer.

Symptoms.—A history of discomfort in the left upper abdomen often closely simulating a gastric or duodenal ulcer was given in a number of the cases. In others a definite enlargement of the spleen or tumour mass in the left upper abdomen could be made out, while in still others the patient gave no history to suggest the presence of an abdominal lesion. When perforation occurs the picture is that of internal hæmorrhage, and in the female ectopic gestation has been the pre-operative diagnosis in a number of instances. When rupture of the aneurysm occurs in the late months of pregnancy the difficulties of diagnosis are very great indeed, and a concealed intra-uterine hæmorrhage is likely to be suspected.

Treatment.—Surgery offers the only hope of cure, and we believe that a wider appreciation of the possibility of the lesion will, as in other conditions, lead to earlier diagnosis and better results.

REFERENCES.

[1] THOMSON, *Johns Hopkins Hosp. Bull.*, 1928, March.
[2] SENGER, *Arch. of Pathol.*, 1928, Feb.

Table showing the references to 58 cases follows

TABLE SHOWING THE REFERENCES TO THE 58 CASES COLLECTED BY THE AUTHORS.

No.	AUTHOR	SEX AGE	SYMPTOMS	ANEURYSM	TREATMENT (OPERATION)	RESULTS	REFERENCES
1	Ahrens, M.	M. 26	Pressure and pain in stomach region, vomiting of blood; swelling of spleen; small pulsating tumours palpated	Size of a fist; ruptured into peritoneum	Patient died before treatment could be begun	Sudden death with signs of internal hæmorrhage	Inaug. Diss., Griefswald, 1892
2	Ayer, J. B.	F. 44	Hæmatemesis; severe abdominal pain	Rupture into stomach not stated	Morphine only mentioned	Sudden death	Boston Med. and Surg. Jour., 1883, cviii, 148.
3	Barlow	M. 61	No symptoms	Two aneurysms: 1 size of filbert nut, and 1 size of pea, about 1 in. apart	Not stated	Death	Trans. Pathol. Soc. Lond., 1899, i, 57
4	Baumgartner, E. A.	F. 48	Sudden abdominal pain; vomiting blood, and blood in stools; indigestion for some time	9 cm. in diameter, not ruptured	None	Death	Surg. Gynecol. and Obst., 1924, xxxix, 462
5	Beaussenat	M. 54	Ulcerations on legs; œdema of left leg; stomach dilated; constipation	Dilatation, 35 cm. long, sac 10 cm. in length, circumference of hen's egg	Local for ulcers; incisions for œdema	Death	Anat. Ges., Paris, 1892
6	Beaussier	F. 60	—	One size of small walnut, others smaller	—	—	Jour. of Med.-Chir. Pharm., 1770, xxxii, 157
7	Berry, J. A.	F. 60	Those of carcinoma of stomach, which was present	Main artery and branches; 5 aneurysms, largest 1 in. in diameter	None	Death (from cancer of gall-bladder)	Lancet, 1927, i, 490
8	Binder	M. 47	Severe pain in region of spleen; later colicky pain; spleen enlarged	Size of walnut, ruptured into peritoncum	None	Death day before operation	Bruns' Beitr. z. klin. Chir., 1918, iii, 205
9	Corson, E. N.	—	The original article was not seen				Med. and Surg. Reporter, 1869, xx, 351
10	Crisp	M.	The original article was not seen			Death	Quoted by Zahn, 1847
11	Davidson, A.	—		One size of bean, 1 size of pea, and others smaller still	—	Death	Liverpool Med.-Chir. Jour., 1884, iv, 210

No.	Reporter	Sex & age	Symptoms	Condition of aneurysm	Treatment	Result	Reference
12	Davis, B. F.	M. 67	Sudden appearance of tumour to left of umbilicus	One	Removed	Recovery	Jour. Amer. Med. Assoc., 1925, lxxxiv, 200; also Med. Press, 1925, N. s. cxix, 115
13	Fachrmann and Urgumow	M. 50	Splenomegalia	8 cm. in circumference, 3 cm. from site of ligature	Splenectomy	Death	Arch. f. klin. Chir., 1925, cxxxvii, 193
14	Fitzwilliams, D. C. L.	F. 27	Sudden intense pain in pit of stomach; collapse, shock	Three aneurysms, largest (ruptured, size of walnut) in hilus	—	Death	Brit. Med. Jour., 1924, ii, 803
15	Garland	M. 52	Dyspnœa on exertion; œdema	Ruptured into peritoneum. Sac about 3 cm. in diameter	Exploratory laparotomy	Death	Boston Med. and Surg. Jour., 1921, clxxxiv, 385
16	Goodheart, J. F.	F. 49	Abdominal distension; headache, vomiting, and diarrhœa; thirst; loud blowing murmur on left side; hæmorrhage per rectum	Size of hen's egg	Ruptured. Caused by abdominal paracentesis	Death	Trans. Pathol. Soc. Lond., 1889, xl, 67
17	Goullioud	F. 50	Tumour in left hypochondriac region for 4 or 5 years	Size of an orange. Contained large clot	None beyond tapping	Death	Bull. et Mém Soc. nat. de Chir., 1928, liv, 402
18	Harnett	—	—	—	Operation: removal of aneurysm	Recovery. Well after 12 years	Ind. Med. Gaz., 1922, 457, lvii
19	Heppner	F. 58	—	Traumatic aneurysm	—	—	St. Petersb. med. Zeits. 1872, n. s. iii, 220
20	Hoegler	F. 61	Spleen greatly enlarged; pulsating tumour palpable and at times visible; occasional vomiting and diarrhœa; abdominal pain off and on for some years previously	Three aneurysms, 7·5, 6·0, 5·0 cm., with smaller ones attached. Ruptured into peritoneum	—	Sudden death from internal hæmorrhage	Quoted by Garland. Wien. Arch. f. int. Med., 1920, Aug., 543
21	Hunt	M. 70	Swelling in left hypochondrium with bruit; girdle pains. Cerebral hæmorrhage	One aneurysm (diagnosed during life as cancer of pancreas)	None	Death (cancer of pancreas also found)	Amer. Jour. Med. Sci., clxxvi, No. II, 195
22	Jourdan		No details given.	Rupture into substance of pancreas		Death	Anat. Ges., Paris, 1881, iii, 76

The whole communication is as follows: "M. Jourdan showed a piece of aneurysm of the splenic artery burrowed into the head of the pancreas, and claimed that death was due to rupture into the peritoneum."

TABLE SHOWING THE REFERENCES TO THE 58 CASES COLLECTED BY THE AUTHORS—continued.

No.	Author	Sex Age	Symptoms	Aneurysm	Treatment (Operation)	Results	References
23	Leudet	F. 70	—	Two tumours: 1 size of pea; 1 size of filbert nut. 2·5 cm. long, 1·5 cm. broad	Drugs only	— Died suddenly 8 days after admission	Gaz. des Hôp., 1852, xxv, 583. Zit. Thereb. Pathol. der Kreislauforgan Lucbarsch, Ostertag, 1915
24	Lindbom	M. 29	Severe abdominal pain. Swelling and pain in right shoulder	Ruptured. 2 cm. in diameter 3 cm. from origin	Supravaginal hysterectomy	Death	Arch. f. Gynäkol., 1923, cxviii, 177. Abst.: Med. Jour., 1923, lxxx, 1348
25	Lundwall and Gödl	F. 29	Internal haemorrhage. in 9th month of pregnancy	Traumatic (revolver)		Died 1½ hours after delivery	Brit. Jour. Surg., 1921-2, ix, 570
26	Marshall	F. 27	—	Size of hazel-nut. In main artery, before Ruptured just. Pancreatic division. Pancreatic hematoma			Zentralb. f. Gynäkol., 1928, lii, 754
27	Mayer	F. 29	Severe lower abdominal pain in 1st stage labour	Size of small nut. Ruptured into stomach	Alkaline waters	Death	Ann. Soc. méd. de Lyon, 1879, xxxi, 327
28	Mayet	F. 59	Abdominal pain for 2 months before; vomiting after meals; loss of weight; haematemesis	Spherical, about size of tangerine orange. Filled with clot	Injections of anti-streptococcus serum.	No apparent benefit, but seemed to cause increase in urine	Trans. Glasgow Pathol. and Clin. Soc., 1905-6, xi, 92; also Glasgow Med. Jour., 1907, lxvii, 309
29	Monro	M. 23	Breathlessness on exertion; pain in chest and legs; swelling of feet.	Two aneurysms: 1 size of small apple, size of small nut and 1 size of nut	Splenectomy	Complete healing	Beitr. z. klin. Chir., 1918, cxi, 205
30	Mulley	F. 23	Anemia; constipation; vertigo and faintness	Not stated	Operation: Jan. 12, 1925. Removal of spleen with tumour	Complete recovery without complications. Discharged in good health 14 days. In good health 17 months later	Deut. Zeits. f. Chir., 1926, cxcviii, 118
31	Naber	F. 51	Feeling of fullness in upper abdomen for 3 months; tumour in left upper abdomen which slowly increased in size, noted for more than 1 year before; no great pain, no vomiting, no blood, urine normal				

No.	Name	Sex and age	Symptoms	Description of aneurysm	Treatment	Result	Reference
32	Osler	M. 30	Tumour in left hypochondrium	Size of coconut	None	Death	Montreal Gen. Hosp. Rep., 1880, i, 266
33	Parker	M. (Age not given)	Rectal hæmorrhage; slight dyspepsia; pain in back	Size of small orange	—	Death 1½ hours after admission to hospital	Edin. Med. and Surg. Jour., 1844, lxii, 132; also Dublin Quart. Jour. Med. Sci., 1844, xxvi, 124
34	Remmels	F. 38	Sudden attack of severe abdominal pain at end of pregnancy	2 cm. long	It was intended to operate, but patient died during preparation for laparotomy	Death	Nederl. Tijds. v. Verlosk. en Gynæc., 1928, xxxvii, 41; also trans.: Zentralb. f. Gynäkol., 1928, lii, 167
35	(a) Reynolds				The original article was not seen		
	(b) van Rooy				The same case, original not seen		
36	Rolleston	F. 37	Not stated. Post-mortem description	Branch. Size of a cherry			S. Afric. Med. Record, 1906, iv, 267
37	Saenger	F. 40	Internal hæmorrhage	Size of hazel-nut 6 cm. from hilum	—	Death	Nederl. Maandschr. v. Geneesk., 1927, xiv, 507 (in Dutch)
38	Suntesson				Operation	Death	Trans. Pathol. Soc. Lond., 1898–9, i, 55
39	Schroeder	F. 32	Hæmolytic jaundice and splenomegalia		The original article was not seen	Death	Zentralb. f. Gynäkol., 1926, i, 1324
							Fürth Svens. Läk.-Sällsk., Stockholm, 1848–9, 1849
40	Schultze	F. 62	None	Two aneurysms. 1 9 cm. from hilum, 1 at hilum, size of hazel-nut	Operation for splenectomy abandoned	Death	Arch. f. Klin. Chir., 1924, cxxxii, 175
41	Selten	F. 31	Hemiplegia	Ruptured aneurysm at middle of the pancreas. Found post mortem	—	Death	Zeigler, Beitrage, 1905, xxxviii, 374
				Saccular: accidentally found post mortem	None	Death	Virchow's Arch., 1893, cxxxiv, 189
42	Smith, H. B. W.	F. 35	Abdominal pain	Ruptured into peritoneum. Branch at hilum	—	Death. No definite aneurysm found at site of rupture	Brit. Med. Jour., 1911, 83

TABLE SHOWING THE REFERENCES TO THE 58 CASES COLLECTED BY THE AUTHORS—continued.

NO.	AUTHOR	SEX AGE	SYMPTOMS	ANEURYSM	TREATMENT (OPERATION)	RESULT	REFERENCES
43	Smith, W. R.	F. 38	Diagnosed as ruptured ectopic gestation	'Large tumour' 3 in. long, middle of pancreas. Retro-peritoneal rupture	Exploratory laparotomy	Death	Jour. Amer. Med. Assoc., 1923, lxxx, 1692
44	Tarozzi	F. 45	Post-mortem report. Aneurysm not suspected durng life	Size of filbert nut	—	Died of cancer of stomach	Ital. Lit. ref. Central. f. Psych., 1904, xv, 700
45	Taylor	M. 14	Pains in joints; paroxysms of precordial pain in left hypochondriac region, constipation, vomiting	Large	None	Death 2 days after admission	Eng. Lit. 1915; Glasgow Med. Jour., 1911, lxxv, 249.
46	Teacher	F. 43		Four aneurysms about ½ in. diameter	None	Death 2 days after admission	Trans. Pathol. Soc. Lond., 1903, liv, 302
47	Trevor, R. S.	M. 53	Entered hospital for operation hydrocele: operation performed. Great tendency to haemorrhages. Diarrhœa and haemorrhage from bowel two days after	Aneurysm of walnut size up of 2 pouches. Another aneurysm ½ in. away, size of hen's egg. Splenic vein dilated		Death 13 days after operation	Trans. Pathol. Soc. Lond., 1885, xxxvi, 151
48	Turner, F. C.	M. 37	Not stated. Sudden death	Size of an orange; rupture into peritoneum	Cyst opened and packed	Death	Arch. gén. de Chir., 1912, viii, 749; 1912, also Lyon méd., 1912, cxviii, 830
49	Villard and Murard	M. 33	Epigastric swelling and pain		Anti-rheumatic drug treatment	Sudden death	Deut. med. Woch., 1908, xxxiv, 177
50	Walz	M. 27	Shivering; joint pains; spleen enlarged and painful	Ten aneurysms from ⅛ in. to ½ in. in size, walls ossified	Opiates for pain only	Death one week after examination	Boston Med. and Surg. Jour., 1856, liv, 297
51	Ware, J.	F. 72	Diarrhœa; severe abdominal pain; vomiting; retention of urine; abdomen much swollen	1.7 cm. diameter. Branching... Ruptured into...	Not stated	Death	Ges. Abhandlungen, Arch. f. pathol. Anat..
52	Weigert	F. 40	Not given, ten report only	Post mor. only			

No.	Name	Sex, Age	Symptoms	Description	Treatment	Death during labour	Reference
53	Wesenberg	F. 32	Collapse and death after birth of a still-born child	5 cm. long, 1 to 2 cm. thick at hilum. Ruptured into peritoneum	—		Zentralb. f. Gynäkol., 1912, xxxvi, 463
54	West, S.	M. 56	Hæmorrhage per anum; vomiting	Branch. Ruptured into stomach. Size not given	Not stated	Death	Lancet, 1885, 518
55	Winckler	F. 25	Splenomegalia	Not stated. At hilum	Splenectomy	Death	Zentralb. f. Chir., 1905, xxxii, 257
56	Yolland	F. 27	Collapsed, no diagnosis possible	'Small'	None	Death	Brit. Med. Jour., 1925, i, 600
57	Zahn	M. 44	Hæmatemesis and melæna	Size of nut. Perforated into stomach and transverse colon	—	Death	Virchow's Arch., 1891, cxxiv, 238
58	Zannini		The original article was not seen				Gaz. med. ital. prov. veneti Padova, 1880, xxiii, 296

SECONDARY HYDROCEPHALUS AS A FACTOR IN THE DIAGNOSIS AND LOCALIZATION OF INTRACRANIAL TUMOURS; WITH ITS INVESTIGATION AND TREATMENT.*

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SUMMARY OF CONTENTS.

I. INTRODUCTION.

THOUGH the symptoms of hydrocephalus secondary to an intracranial tumour are usually regarded as being essentially those of the underlying condition, it frequently happens that no localizing signs whatever are present. In such cases the intracranial tumour itself may remain latent throughout the greater part or whole of the clinical course, and the symptoms be entirely those of acute or subacute hydrocephalus—that is to say, those which are usually regarded as the 'general symptoms' of brain tumour, namely, headache, vomiting, vertigo, and papillœdema. In some cases, however, the vertigo may suggest the presence of a tumour in or adjacent to the posterior fossa of the skull, and result in a presumptive localization of the lesion which may be adduced as evidence in favour of a decompression operation below the tentorium rather than above it ; or mental symptoms may appear early in the course of the condition and suggest the presence of a tumour in the frontal lobe rather than one in the base of the brain obstructing the outflow of cerebrospinal fluid from the lateral ventricles. Thus 'false localizing signs'

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may appear and lead to an erroneous localization and to fruitless attempts at exploration and removal. False localizing signs have been recognized as occurring frequently as a result of vascular changes and œdema of the brain in association with intracranial tumours, but hitherto they have not been recognized as a potential source of error in those cases in which a tumour of the brain has produced internal hydrocephalus. Even when they have been regarded as sources of error, it has not always been recognized that the key to a complete diagnosis depended upon the diagnosis of hydrocephalus on the basis of the so-called general symptoms of tumour of the brain ; or that often the general symptoms present are the result of secondary hydrocephalus, and the localizing signs present are due to the hydrocephalus and not to the tumour itself. Because of the possibility of error in diagnosis in such cases, it has been thought advisable, using seven typical cases as a text, to consider the influence of secondary hydrocephalus upon the diagnosis and localization of intracranial tumours ; to consider the means whereby the presence of hydrocephalus as a complication and the exact localization of the tumour may be determined ; and to discuss the influence of such a complication upon the choice of treatment.

II. THE CIRCULATION OF THE CEREBROSPINAL FLUID.

Though it was suggested by Faivre[1] in 1854 that the choroid plexuses were the source of the cerebrospinal fluid, it was not until 1919, when Dandy[2] published the results of his experiments, that it was proved that they were its only source. The way in which it is produced is still in doubt, for by different observers it has been thought to be produced by filtration and by secretion. That the constituents of the blood-plasma are present in it in about the same proportions as in the blood seems to indicate that the process is one of filtration, but the holding back of some substances artificially introduced into the blood-stream suggests that the cells of the choroid plexus have some power of selection over the substances which pass into the cerebrospinal fluid.

Though some of the cerebrospinal fluid may pass into the perivascular spaces, it is probable that most of it is absorbed into the veins. The observations of Weed[3] showed that this absorption of cerebrospinal fluid probably takes place in the subarachnoid space by a process of diffusion, but there is some evidence that absorption of cerebrospinal fluid takes place into the spinal veins as well.

The circulation of the cerebrospinal fluid is a more or less independent one of its own within and without the brain and spinal cord, consisting primarily of a steady tide from its source in the choroid plexuses to the area of absorption in the subarachnoid space and the spinal canal, together with certain superadded waves imparted to it by the vascular pulsations operating within the rigid cranium. The fluid constantly accumulates within the lateral ventricles and circulates in only one direction. From the lateral ventricle it passes through the foramina of Monro into the third ventricle, through the aqueduct of Sylvius into the fourth ventricle, and thence, by way of the foramen of Magendie and the foramina of Luschka, into the subarachnoid spaces about the brain and the spinal cord.

III. THE ETIOLOGY OF HYDROCEPHALUS IN INTRACRANIAL TUMOURS.

Four different mechanisms have been suggested to explain the development of hydrocephalus in the course of intracranial tumours :—

1. Direct mechanical obstruction of the circulation of the cerebrospinal fluid depends upon the accidental localization of the tumour in such a position that it directly impinges upon the channels through which the fluid normally circulates. This effect is produced by tumours blocking one or both foramina of Monro, involving the third ventricle, obstructing the aqueduct of Sylvius, involving the fourth ventricle, or obstructing the foramina of Luschka or that of Magendie. The inevitable result of tumours so placed is the accumulation of cerebrospinal fluid above the level of the obstruction. In these cases hydrocephalus and 'general symptoms' usually appear early, and localizing signs are often absent or appear late as 'false localizing signs'. Such true localizing signs as are present are soon obscured by general symptoms and false localizing signs, so that an error in localization is particularly apt to occur. Since, however, in these cases any treatment adopted must be essentially general, at least in the first place, in that it is determined by the general symptoms of the patient, the initiation of effective treatment must depend upon the prompt recognition of the presence of hydrocephalus. Such a prompt diagnosis is particularly necessary in the case of a tumour or other lesion in the sites already mentioned. It is possible that in such cases the primary mechanical obstruction is only partial and that the vicious circle set up by the gradual development of hydrocephalus disturbs the adjacent brain tissue and makes the obstruction complete, thus hastening the development of general symptoms and at once placing the patient in a dangerous condition. Such is the urgency of the problem presented when secondary hydrocephalus is the result of mechanical obstruction to the circulation of the cerebrospinal fluid. It is even more urgent in those cases in which hydrocephalus is produced indirectly by a tumour situated in other parts of the brain, as, under those conditions, the chances of employing effective local treatment are greater. The mechanism by which the tumour produces secondary hydrocephalus in such cases is at present undecided.

2. By some writers the indirect production of hydrocephalus is believed to be due to pressure upon the great vein of Galen, either directly or indirectly, and the consequent increased production of cerebrospinal fluid by the choroid plexuses in the lateral ventricles. Basing his argument partly upon anatomical and partly upon clinical evidence, Stopford[4] has recently described this mechanism as the only important one in the indirect production of hydrocephalus in cases of intracranial tumour. Sargent[5] has, however, described an anatomical feature of the opening of the great vein of Galen into a lacuna at the posterior end of the free border of the falx cerebri which would make this mechanism unlikely in the absence of direct mechanical obstruction of the vein by pressure against adjacent parts. Stopford, however, overcomes this difficulty by pointing out that hydrocephalus is more common in cases of tumour of the posterior part of the cerebrum and of the posterior fossa, and concludes that this localization supports his suggestion that direct pressure

is produced upon the great vein of Galen either from above or below as a result of the unyielding character of the tentorium cerebelli. Dandy[2] believes that obstruction of the great vein of Galen is a rare cause of secondary hydrocephalus. It is possible that it is a cause in some cases and a contributing factor in many.

3. Actual distortion of the brain-stem by lateral displacement and torsion, and secondary obstruction to the circulation of the cerebrospinal fluid at its most vulnerable point in the aqueduct of Sylvius by pressure of the hindbrain against the unyielding edge of the tentorium cerebelli, has been suggested as a more probable explanation. Russell Brain[6] believes that this is the mechanism operating in the majority of cases of intracranial tumour complicated by hydrocephalus, and cites in support of it the frequency with which distortion of the brain-stem is found at autopsy in cases of secondary hydrocephalus.

4. In addition, it has been suggested that the obstruction to the circulation of the cerebrospinal fluid occurs in the neighbourhood of the foramen magnum. An increase in the intracranial volume, especially above the tentorium, results in the expulsion of cerebrospinal fluid, pressure is exerted upon the contents of the posterior fossa of the skull, the structures in the neighbourhood of the foramen magnum are displaced, and the outlets of the cerebrospinal fluid are obstructed. Thus a vicious circle is set up and internal hydrocephalus rapidly develops.

It is possible that the first three of the factors mentioned may all play some part in individual cases ; but, whatever mechanism is chiefly responsible, it is important to recognize that, apart from those cases in which direct mechanical obstruction has occurred, the hydrocephalus is the direct result of increased pressure within the cranium and that, once it has begun to develop, a vicious circle is established which soon results in the development of a condition which endangers the vision if not the life of the patient.

It is equally important to recognize that in those cases in which secondary hydrocephalus has developed indirectly, the order in which the symptoms and signs appear is of paramount importance—true localizing signs first if the part affected is not a silent area, general symptoms of increased intracranial pressure, followed by false localizing signs as a result of the increased intracranial pressure. It is true that the different phases may merge into one another. but it is none the less essential that the sequence of events should be remembered if errors in localization are to be avoided.

IV. PERSONAL CASES.

Case 1.—Glioma and diffuse gliosis of the pons, with secondary hydrocephalus and symptoms suggestive of a cerebellar lesion.

H. A., male, age 30 years, was admitted on Sept. 11, 1928, complaining of headache, vomiting, loss of vision, dizziness, and hæmatemesis of six weeks' duration.

HISTORY.—The patient was perfectly well until six weeks before admission. The illness began with pain in the back of the neck. There had been severe headache on the top of the head, varying somewhat from time to time. Vomiting had been present daily since the onset and was worse when the headache was severe. Blood appeared in the vomitus on one occasion. The vision was less acute, and

the patient had been disinclined to read on account of the headache. He staggered as he walked. The previous history was negative, but two of the patient's family had had tuberculosis, and one had died of it.

ON EXAMINATION.—The mental condition was normal. There was some concentric narrowing of the visual fields, more obvious on the left side. There was some blurring of the optic discs, but no obvious swelling could be seen. Nystagmus : slight, irregular jerks were present, more on looking to the left than to the right ; there was a long, slow swing on looking to the left. Hearing was diminished in both ears, and bone conduction was more prolonged than air conduction. There was no evidence of active disease in either the right or the left ear. Some words were slurred in speaking. The left corneal reflex was sluggish. There was slight weakness of the lower part of the right side of the face for voluntary movements. The other cranial nerves were normal.

In the upper limbs motor power was poor, tone was decreased equally on the two sides, and the deep reflexes were present and equal. In the lower limbs motor power was poor, tone was decreased more in the left leg than in the right, the knee- and ankle-jerks were more active on the right side than on the left, and the plantar reflexes were doubtful. The abdominal reflexes on the right side were less active than those on the left. The patient walked on a broad base, swayed from side to side, and tended to go towards the left. There was tremor of the left hand and arm on extension. With the finger-nose test there was slight tremor on movement towards an object, more obvious in the left hand than in the right. Rebound was not so good in the left arm as in the right. With the heel-knee test there was no obvious abnormality. The pulse-rate was 70 ; the blood-pressure was 135 systolic, and 90 diastolic. The other systems were normal.

There was tenderness below the external occipital protuberance on percussion. On X-ray examination the left mastoid cells were not so clear as the right.

The cerebrospinal fluid was normal. The Wassermann reaction in the fluid was positive with 5 minimum hæmolytic dilutions. In the blood the Wassermann reaction was negative.

SUBSEQUENT PROGRESS.—Sept. 15, 1928.—The patient was shivering and complaining of the cold frequently, a symptom which had been present since the onset of the illness.

Sept. 18.—There was a feeling of chilliness and dampness in the distribution of the first and second divisions of the left trigeminal nerve. On objective examination there was analgesia in the distribution of the ophthalmic division of the left trigeminal nerve, and impairment of pain sensation in that of the maxillary division.

Oct. 3.—The optic discs were slightly more blurred. Vomiting was not so frequent, but headache was more frequent. There was complete analgesia and loss of tactile sensation in the first and second divisions of the left trigeminal nerve.

Oct. 9.—There was definite nystagmus on looking to the left. The patient walked staggering from side to side with the head bent forward on the chest. There was pain in the back and some difficulty in passing urine.

Oct. 11.—Both optic discs were swollen to 4 dioptres. The retinal veins were distended and there were hæmorrhages in the retina.

Oct. 13.—An operation was performed to decompress the posterior fossa and the supratentorial region immediately above it. Above the tentorium the dura mater was very tense on both sides, more so on the left side. Below the tentorium the dura was not unusually tense. Before the operation, while anæsthesia was being induced, there was some difficulty with breathing which was overcome as soon as the intratracheal tube was inserted. About ten minutes after the operation respiration ceased, but recovered with artificial respiration. Six hours after the operation the patient had not recovered consciousness, and the respiration was more rapid and stertorous. Death occurred suddenly.

POST-MORTEM FINDINGS.—Nothing abnormal was found in the bones of the skull or the dura. The convolutions of the brain were very greatly flattened, pale,

and anæmic. The pons and the medulla appeared to be much flattened, distinctly broadened, and their surface markings were obliterated as if from pressure from within the brain. On section, the lateral ventricles were much distended and the aqueduct of Sylvius was obstructed at the level of the pons. The third ventricle and infundibulum were also distended.

Microscopically, complete vertical sections through the pons and medulla showed, at about the junction of the two, a large, more or less diffuse glioma. varying much in structure in different parts—in some more cellular, in others more fibrillary. The general type was that of a spongioblastoma multiforme, with spindle-shaped, irregular and some gliomatous giant cells. There was a diffuse ' gliosis ' or ' gliomatosis ' around the more definite area of tumour on the left side of the pons. Some of the little vessels in the tumour and neighbourhood showed aggregations of small lymphocyte-like cells around them.

Case 2.—Glioma of the cerebellum and secondary hydrocephalus in a child; obesity; symptoms simulating those of a degenerative condition of the cerebellar and pyramidal tracts. (*Figs.* 161, 162.)

H. G., female, age 4 years, was admitted on Aug. 29, 1928, with a history of difficulty in walking for eighteen months.

HISTORY.—Up to eighteen months before admission the development of the child had been normal. Then it was noticed that she had some difficulty in walking, which became progressively worse until she was unable to stand. Shortly afterwards a squint appeared and gradually became more obvious. Her previous health had been good, and two other children in the family were healthy.

ON EXAMINATION.—The child was intelligent and well-developed. The skull was abnormally large, but no gross abnormality was found radiologically. The gait was very ataxic, and walking without support was impossible. There was a right external strabismus, but no evidence of diplopia could be elicited. The ocular movements were inco-ordinated, but there was no definite nystagmus. The ocular fundi showed definite optic atrophy. The deep reflexes were exaggerated, and the plantar reflexes were extensor on both sides. There was no obvious interference with cutaneous sensibility. Excepting for the presence of 4 cells per c.mm., the cerebrospinal fluid was normal.

At a subsequent examination the following additional signs were noted. The pupils were equal and moderate in size, reacting sluggishly to light and accommodation. The right corneal reflex was sluggish. The left side of the face was weak for voluntary movements. The upper limbs were normal. Motor power and muscle tone were apparently good in the legs ; the knee- and ankle-jerks were exaggerated, those on the right side being more active than those on the left. Co-ordination was good in the arms, but much impaired in the legs. There was some urgency of micturition. The skull was rather large, and its circumference (21¾ in.) approximated to that of the chest.

SUBSEQUENT PROGRESS.—Nov. 4, 1928.—The mental condition was good throughout. There was slight variation from time to time in the signs of a pyramidal lesion, the plantar reflexes being sometimes flexor and sometimes extensor. For a period of one week the patient was very drowsy and took little interest in her surroundings.

Dec. 3.—The right lateral ventricle was punctured through an opening in the skull above and behind the right ear. Eighty c.c. of cerebrospinal fluid were withdrawn in small amounts at a time, and replaced at each stage by air. At the end of the operation the patient vomited, the breathing became stertorous, and coma suddenly supervened. On the withdrawal of a small amount of cerebrospinal fluid the breathing became normal and consciousness was regained. The patient slept a little after the operation and for four hours was apparently normal. She then became cyanosed and died suddenly.

X-ray examination after the injection of air showed that the right ventricle

was very large. No air had entered the left ventricle. The appearance of the skull suggested hydrocephalus.

POST-MORTEM FINDINGS.—The brain was distinctly large for a child of this age, showed great general flattening, and gave the impression of a thick bag full

FIG. 161.—*Case 2.* Glioma of the cerebellum, secondary hydrocephalus, and obesity in a child : showing tumour and dilatation of the infundibulum.

of fluid. The infundibulum was ballooned out into a thin-walled sac, and on section the lateral ventricles were much distended and full of fluid, with thinning of the overlying brain tissue. A very irregular sheet of tumour was found over

the cerebellum and the neighbouring parts of the pons and medulla, and around the seventh and eighth cranial nerves on the right side. The tumour formed a thick collar around the medulla, lay in the foramen magnum, and probably caused compression. The naked-eye appearance of the tumour was suggestive
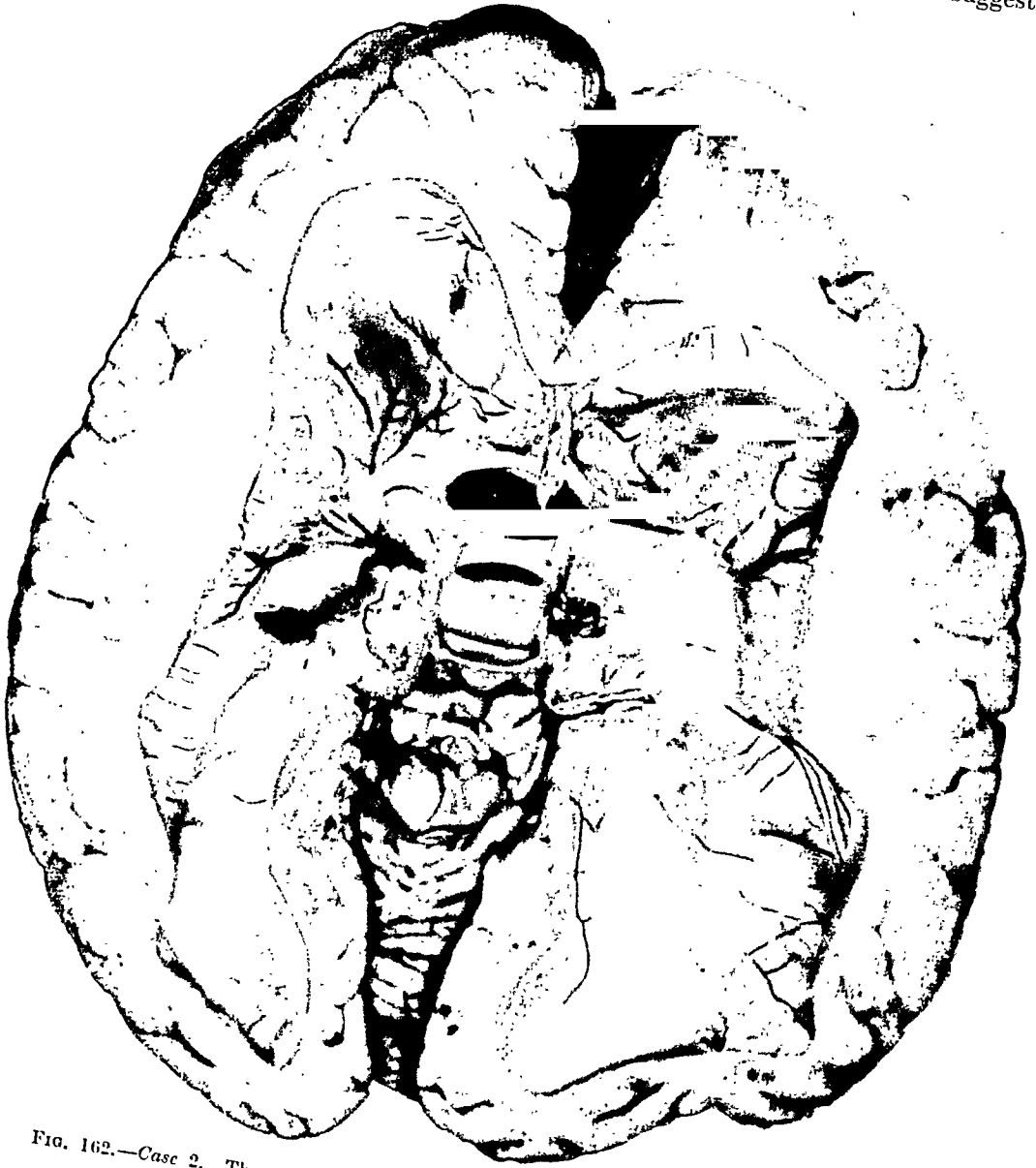
FIG. 162.—*Case 2.* The same as *Fig. 161* showing dilatation of the third and lateral ventricles, and collar of tumour above the cerebellum.

of endothelioma. Sections, however, showed a highly cellular tumour, actively malignant—gliomatous with numerous small glial cells and a rich glial network— a fibrillary astrocytoma.

Case 3.—Glioma of the third ventricle and infundibulum, with secondary hydrocephalus and symptoms suggesting a tumour of the frontal lobe. (*Figs.* 163, 164.)

M. H., female, age 45 years, was admitted on June 14, 1928, complaining of 'a nervous breakdown', irritability, poor memory, headaches, vomiting, and loss of energy of eight months' duration.

HISTORY.—The patient began to suffer from lack of energy about eight months before admission. For many years she had had headaches on top of the head and in the occipital region. During the previous six months they had been severe and
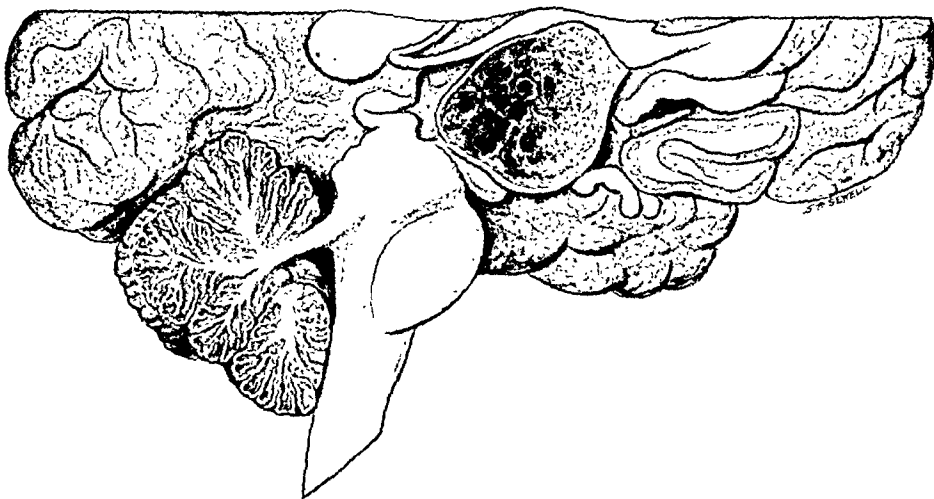
FIG. 163.—*Case* 3.   Glioma in the region of the third ventricle and infundibulum with secondary hydrocephalus : sagittal section showing position of the tumour.
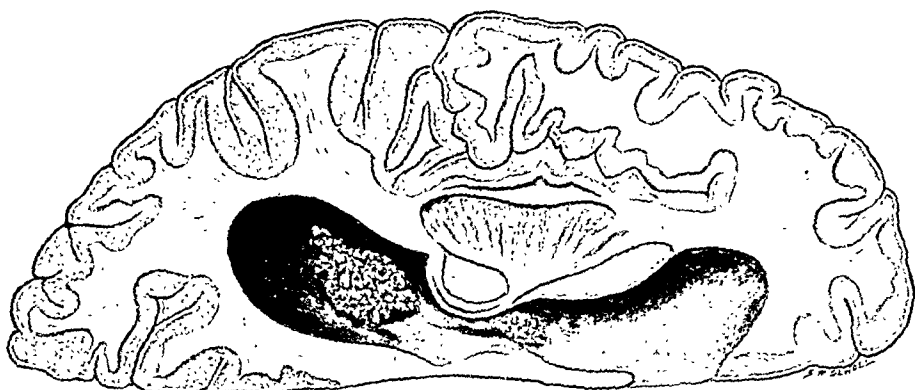
FIG. 164.—*Case* 3.   The same as *Fig.* 163, showing dilatation of lateral ventricle.

associated with attacks of vomiting and nausea. During the same time the memory had been getting steadily worse. Although irritable at times, for the most part the patient had been happy and contented, and did not appear to realize the seriousness of her mental deterioration. The previous history was negative. With regard to the family history, the patient's husband was alive and well and she had three children living, one with heart disease.

ON EXAMINATION.—The mental condition was best described as facile ; the patient showed a tendency to joke in everything she said. The memory was very poor, especially for recent events ; words spoken a few minutes before could not be recalled. Attention could not be maintained. The right pupil was slightly larger than the left, and both reacted to light and accommodation. The right optic disc was swollen to 2 dioptres, and the left to 4 dioptres with hæmorrhages into the retina. Vision was fairly good. The visual fields could not be measured satis-factorily on account of inattention, but there appeared to be extreme concentric contraction of the fields on both sides. The other cranial nerves were normal.

Sensation was normal. In the upper limbs muscle tone was slightly greater on the right side, and the tendon reflexes were present and equal on the two sides. In the lower limbs muscle tone was slightly greater on the right side, the knee- and ankle-jerks were present and equal, and the plantar reflexes were both flexor. The abdominal reflexes were present and equal. There was tremor of the right hand and arm on extension. The finger-nose test was carried out clumsily, worse on the right side than on the left. There was incontinence of fæces. The blood-pressure was 120 systolic, and 70 diastolic. The other systems were normal.

SUBSEQUENT PROGRESS.—A decompression operation was performed in the left fronto-parietal region and the dura opened. No local abnormality was found.

June 27, 1928.—The patient was still comatose twenty-four hours after the operation.

June 28.—The patient was conscious, but unable to speak or swallow. The right arm and leg were spastic, and the right side of the face was paralysed. The temperature was raised, and the pulse- and respiration-rates were increased. Death occurred the following day.

POST-MORTEM FINDINGS.—The convolutions of the brain showed considerable general flattening due to a moderate degree of hydrocephalic dilatation of the ventricles. In the region of the infundibulum there was a slightly projecting, firm, rounded swelling suggestive of a subjacent tumour. On vertical section this was found to be due to a globular glioma-like tumour about the size of a walnut, centrally placed, and occupying the position of the third ventricle and infundibulum. The tumour was slightly whiter and more spongy than the surrounding brain tissue ; and its centre showed some patchy, reddish-brown mottling suggestive of necrosis, with dilated vessels and some small areas of hæmorrhage.

Microscopically. sections showed the tumour to be a glioma of the spongio-blastoma multiforme type with considerable variations in the cells, some showing as branching astrocytes, others as spindle-shaped to entirely irregular cells. There were areas of necrosis, and in some parts dilated and congested vessels from some of which hæmorrhage had occurred.

Case 4.—Endothelioma (meningioma) of the fronto-parietal lobe, with secondary hydrocephalus, glycosuria, and sudden death. (*Figs.* 165, 166, 167.)

L. P., female, age 27 years. was admitted on Sept. 16, 1927, in a state of coma.

HISTORY.—Headache had been present for one year, and gradually increasing drowsiness for three weeks. Mental symptoms had been present for a few days before admission.

ON EXAMINATION.—The temperature was 97·8° and the pulse-rate 68. The patient was in resistant coma, incontinent of urine, and just reacted to painful stimuli. All the reflexes were increased. There was slight head retraction, and the right side was stiff. The blood-pressure was 124 systolic, and 75 diastolic. The cerebrospinal fluid was not under pressure. was clear, contained 10 lymphocytes per c.mm. and 0·1 per cent of protein. There was a loose cough, but no adventitious sounds were discovered in the chest. The urine was normal.

SUBSEQUENT PROGRESS.—Sept. 17, 1927.—The patient could be roused, and spoke about her pain. Papillœdema was present on both sides, on the right side to 3 dioptres and on the left side to 2 dioptres.

Sept. 18.—The coma was increasing, and the limbs showed flaccidity and rigidity at different times.

Sept. 19.—Coma was complete, and the temperature, pulse-rate, and respiration-rate were increasing. The limbs were completely flaccid. The pupils were moderate in size, the left larger than the right, and both were fixed. The abdominal reflexes were absent and plantar reflexes flexor. Severe sensory stimulation caused slight
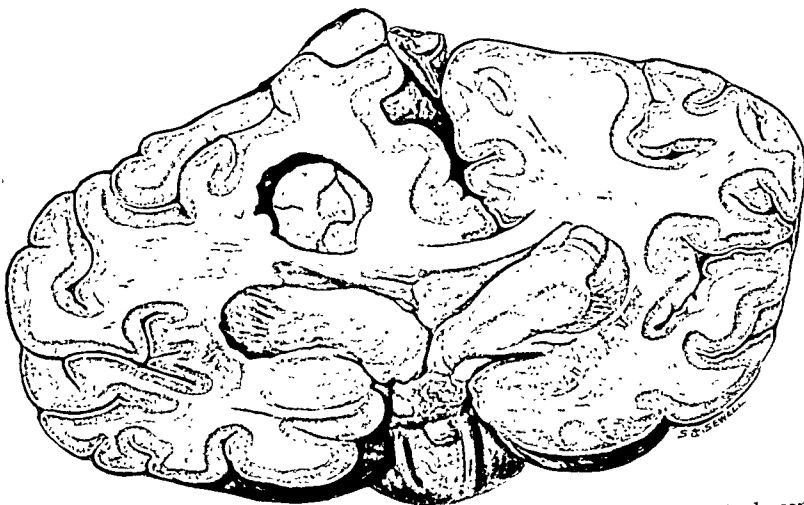
FIG. 165.—*Case* 4. Meningioma of the fronto-parietal lobe with secondary hydrocephalus: showing displacement of structures in the middle line to the opposite side.
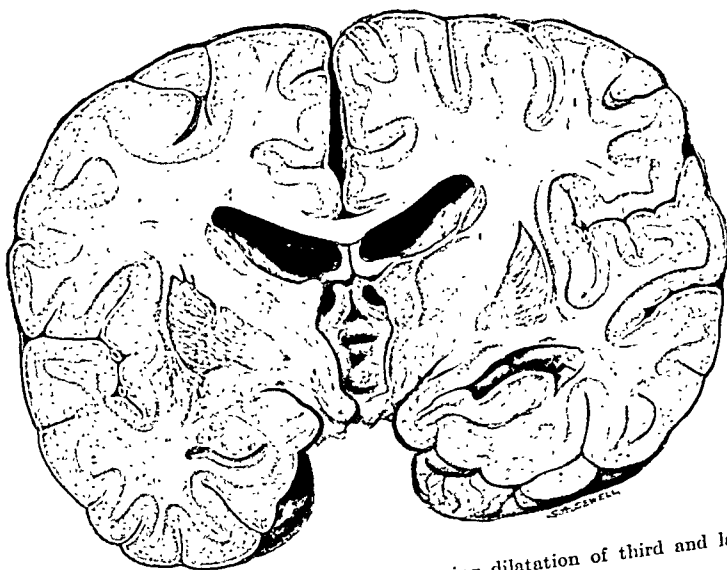
FIG. 166.—*Case* 4. The same as *Fig.* 165, showing dilatation of third and lateral ventricles, and of foramina of Monro.

movement. The papilloedema was increasing. The urine was acid, contained no albumin, but there was a moderate amount of sugar and acetone.

The operation of decompression was about to be performed, but the patient's respiration failed during the shaving of the head; death ensued.

POST-MORTEM FINDINGS.—An endothelioma (meningioma) was found in the left frontal region and pressing on the Rolandic area. There was also marked hydrocephalus with pressure on the medulla.
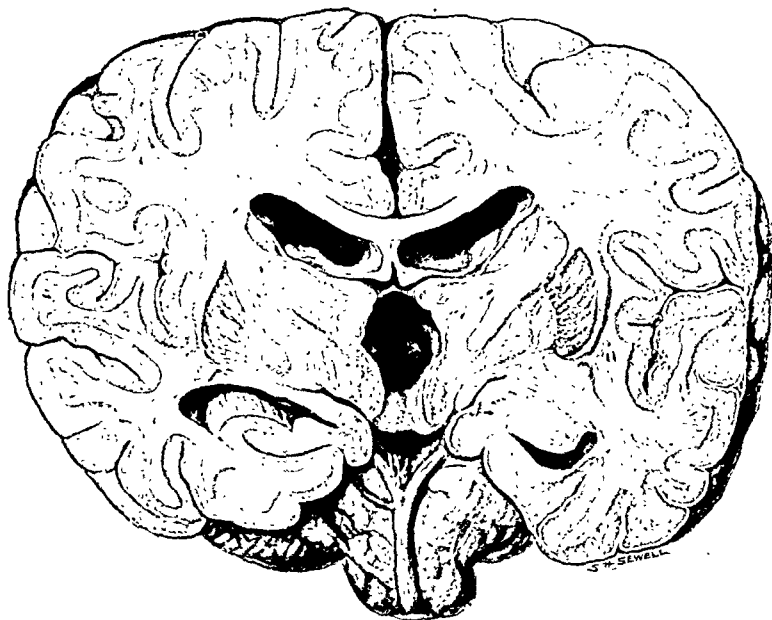
FIG. 167.—*Case* 4. The same as *Fig.* 165, showing dilatation of the third ventricle and the aqueduct of Sylvius.

Case 5.—Glioma of the cerebellum, secondary hydrocephalus, and signs suggestive of a supratentorial tumour.

R. B., male, age 25 years, was admitted on Jan. 17, 1927, with a history of headache and vomiting for two months.

HISTORY.—Two months before admission the patient complained of bitemporal headaches and pain in the back of the neck. Speech became defective and was progressively worse before admission. Vision was progressively impaired and the gait became unsteady.

SUBSEQUENT PROGRESS.—Optic neuritis was evident one month after admission. Vomiting occurred occasionally every day, especially in the morning or at midday. A right subtemporal decompression was performed one month after admission, and a left subtemporal decompression one month later. Nothing abnormal was noted at the time of either operation.

The physical signs one week after the second operation were as follows. The right pupil was smaller than the left, and both reacted sluggishly. A divergent strabismus was present and the movements of all muscles supplied by the third nerve were weak. There was marked papilloedema of both optic discs, more obvious on the right side. There was a flaccid paralysis of the right side of the face and slight weakness of the left side. The patient refused to speak, but understood much of what was said. Hearing was diminished. The tongue protruded towards the right side. The condition of the sensory system was difficult to determine, but no gross loss was detected. A right-sided hemiplegia appeared after the second operation. In the upper limbs the tendon reflexes were more active on the right side than on the left. In the lower limbs the knee- and ankle-jerks were present and equal, ankle clonus was present on the right side, and the right plantar reflex resulted in dorsiflexion. The abdominal reflexes were absent on the right side. Incontinence of urine and faeces appeared after the second operation. The other systems were normal.

Death occurred fourteen weeks after admission.

POST-MORTEM FINDINGS.—The whole brain was extremely soft and, especially over the upper part of the cerebral hernia, breaking down and necrotic. After fixation the brain was cut in a series of horizontal sections and a large cerebellar tumour was found. The tumour was more or less centrally placed in the cerebellum, its lower part rather more to the right and its upper part slightly towards the left. It was soft, slightly pinkish-grey to ash-coloured, and fairly well-defined in its circumference, which was mostly in contact with and more or less embedded in distorted cortex. In the substance of the tumour there were a few small necrotic pseudo-cysts.

Microscopically, the tumour was highly cellular, the cells being 'undifferentiated' with small rounded to slightly oval nuclei, rich in chromatin and staining darkly, with a small to moderate amount of surrounding protoplasm, the outlines of which are very indefinite. The cells showed a distinct tendency to be arranged in irregularly rounded islets or alveoli, with thin-walled capillaries and scanty delicate connective tissue between them forming a scanty reticulum around these islets. According to Bailey and Cushing's classification, the tumour appeared to be a 'medulloblastoma'.

Case 6.—Cerebellar arachnoid cyst, with secondary hydrocephalus and symptoms suggesting a lesion of the pyramidal tracts. (*Fig.* 168.)

W. S., male, age 36 years, was admitted on Oct. 25, 1928, complaining of pain and stiffness in the back of neck.

HISTORY.—Three months prior to admission the patient began to have pain at the back of the eyes at the end of the day, after work. This pain had gradually
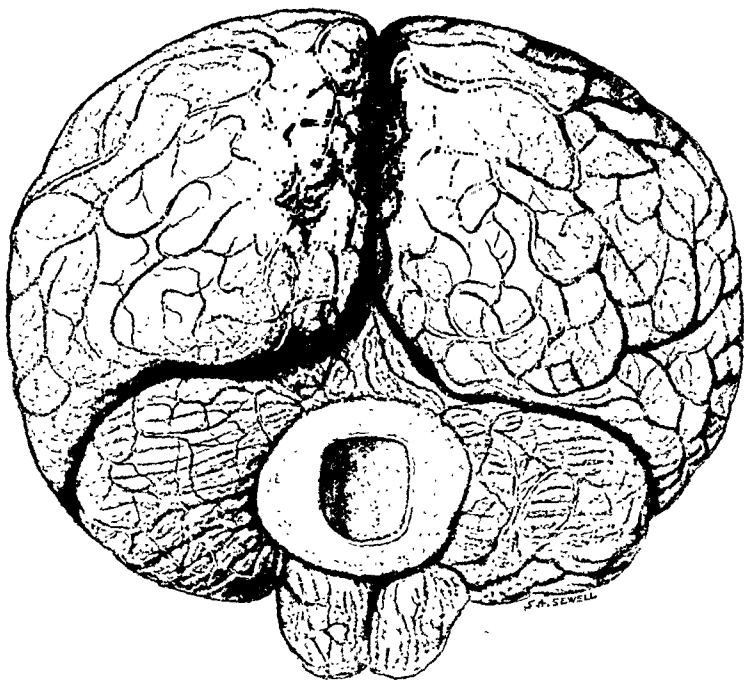
FIG. 168.—*Case* 6. Cerebellar arachnoid cyst with secondary hydrocephalus: showing cyst and flattening of the cerebral convolutions.

spread backwards, and at the time of admission it centred at the back of the neck and the muscles there seemed stiff. His previous health had been good.

ON EXAMINATION.—The pupils reacted to light and accommodation. Vision and the visual fields were normal. The optic discs on both sides were indistinct.

and there was a small hæmorrhage in the right retina. There were no nystagmus, sensory changes, or tremor of the hands, and the arm-jerks were normal. The knee-jerks were exaggerated, the ankle-jerks were present, there was a tendency to ankle clonus, and the plantar reflexes were extensor. The Wassermann reaction was positive in the blood and cerebrospinal fluid.

SUBSEQUENT PROGRESS.—Oct. 27, 1928.—Lumbar puncture was performed and the fluid was under pressure. The patient stood it very well and there was no severe reaction.

Oct. 30.—The patient was allowed up in the afternoon as he said that the headaches, which were not relieved by lumbar puncture, were easier when he was up. He appeared as usual at night and slept well until 5.30 a.m. He then said he was not feeling well and looked tired. Five minutes later he was found propped up in bed, cyanosed, covered with cold perspiration, and quite unconscious. The breathing became feebler, the pulse was slow and weak, and the patient died within twenty minutes.

POST-MORTEM FINDINGS.—The brain showed flattening of the convolutions and a convex bulge on the left side. Some of the surface vessels were obliterated. The cerebrospinal fluid was clear, and a large amount of fluid was present in the cerebellar fossa. The vermis of the cerebellum and the pons were compressed and flattened. In the middle line at the base of the cerebellum a space two inches in diameter was occupied by a thin-walled cyst. The arachnoid membrane in the region of the right auditory nerve was much thickened. The ventricles of the brain were distended with clear fluid. The cyst was diagnosed as a cerebellar arachnoid cyst.

Case 7.—Glioma of the upper pons, midbrain, and interpeduncular space, secondary hydrocephalus and symptoms suggesting congenital hydrocephalus. (*Figs. 169. 170.*)

J. P., male, age 6 years, was admitted on April 12, 1926.

HISTORY.—At the age of 5 months the patient was diagnosed as suffering from primary optic atrophy of both eyes. He complained of slight pain in the left leg about four months before admission. One month later he had a sudden attack of headache, vertigo, and vomiting. He was unable to walk after this attack, and trembling of the hands and knees appeared. His condition became steadily worse, his character changed, he became perverse and difficult to manage.

ON EXAMINATION.—The pupils were equal and dilated, and did not react to light. The right eye was completely blind ; with the left eye he could count fingers. There was weakness of both external recti, and the eyes could not be elevated above the mid-horizontal line. Both optic discs showed secondary optic atrophy. There was difficulty in opening the mouth. There was weakness of voluntary movements of the face on the left side. The pulse was rapid. There was bilateral spastic paraplegia. The patient was unable to feed himself, and had incontinence of urine and fæces. He died on the seventh day after bilateral subtemporal decompression.

POST-MORTEM FINDINGS.—The head was of distinctly large size as compared with the rest of the body. The skull was very thin, and both anterior and posterior fontanelles were still membranous. The convolutions of the brain showed definite flattening and pallor. A soft, tumour-like mass was found in the interpeduncular space, extending from the upper margin of the pons to well in front of the optic chiasma. The mass involved the chiasma, the tuber cinereum, and the infundibulum, and extended on each side to the tips of the temporosphenoidal lobes. The pituitary fossa was pressed upon, and was wider and shallower than normal. The pituitary body was pressed against the bottom of the fossa, and was saucer-shaped and widened. The posterior halves of the intracranial parts of the optic nerves were involved in the tumour ; the left being narrowed and degenerated, the right being soft, bulky, and œdematous. The sixth nerves appeared to be compressed against the bone by the tumour.

On horizontal section of the brain a marked degree of chronic hydrocephalus

was apparent, involving both the lateral and third ventricles. Embedded in the floor of the third ventricle there was a soft, rounded pinkish-brown tumour, projecting rather more to the right side than to the left. The tumour appeared to be cystic in nature, but, on cutting into it, it was found to be soft peripherally, and necrotic and hæmorrhagic in the centre.

Microscopically, the tumour was composed of small cells with dense, spherical nuclei, surrounded by a rather indefinite, feebly-staining cytoplasm. Between them
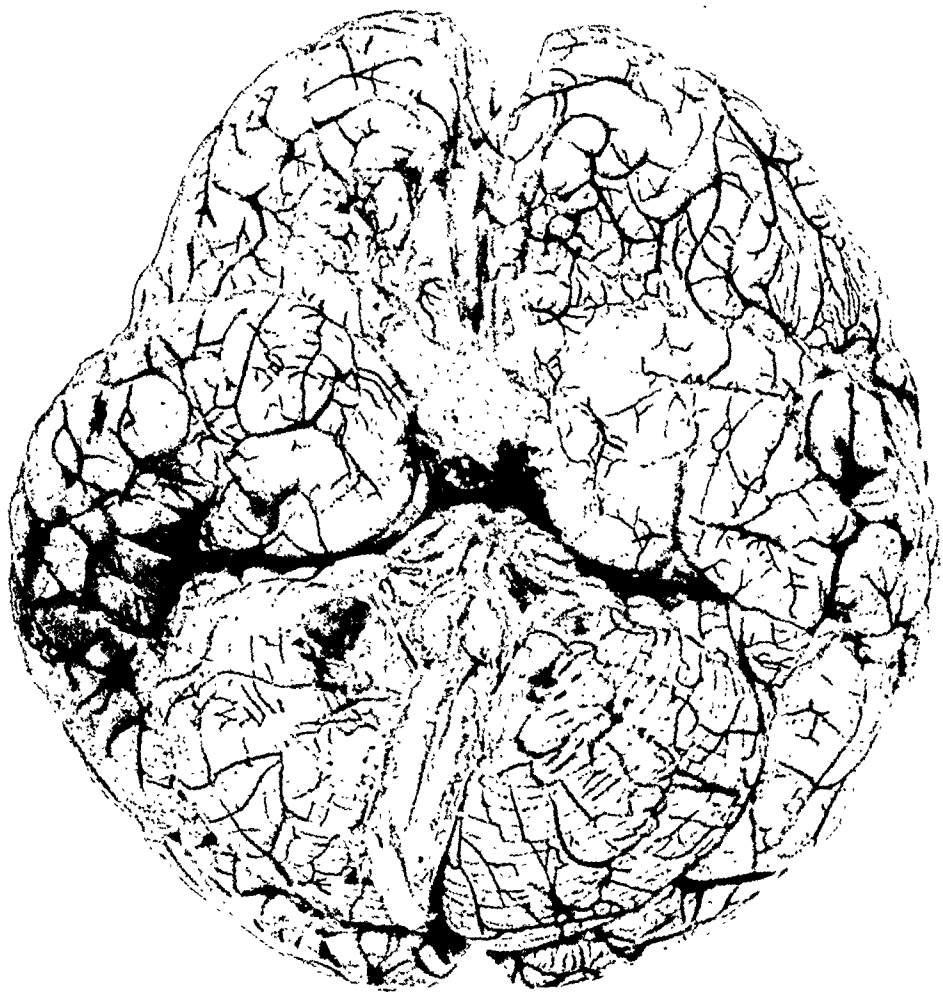
Fig. 169.—*Case* 7. Glioma of the upper part of the midbrain and the interpeduncular space in a child : view of brain and tumour from below.

was an indefinite material which did not stain for neurofibrillæ, neuroglia, or for connective tissue. Some of the small blood-vessels showed proliferation of their endothelial cells, sufficient in some cases to fill their lumen and form little solid masses. Both optic nerves showed thickening of their fibrous tissue and framework, with in the left advanced, and in the right complete, atrophy and disappearance of the nerve-fibres.

V. CLINICAL COMMENTARY.

The cases detailed above illustrate most of the points of interest in the diagnosis of cases in which secondary hydrocephalus is a complication and in the localization of the focal lesions present.

Case 1 was that of a man of 30 who for six weeks had suffered from head-

FIG. 170.—*Case 7. The same as Fig. 169 : the tumour and lateral ventricles viewed from above.*

ache, vomiting, loss of vision, and vertigo. Physical examination revealed a series of signs—nystagmus, hypotonia, a tendency to fall towards the left— which seemed to point to a lesion of the left side of the cerebellum or adjacent to it. The symptoms continued and became more acute, the patient reeled as he walked, the head was carried forward on the chest, and the optic discs,

which at first were only blurred, in three weeks were found to have swollen to 4 dioptres. In addition there appeared analgesia in the ophthalmic and maxillary divisions of the left trigeminal nerve, and doubtful signs of a pyramidal lesion on the right side. A tumour of the posterior fossa of the skull was diagnosed and a subtentorial decompression advised. At the operation and at the subsequent autopsy it was found that the whole of the increase in intracranial tension was above the tentorium and that there was no increase in tension whatever below the tentorium. In reviewing the clinical features of the case the general symptoms were accepted as general symptoms of an intracranial neoplasm, and as such localizing signs as were present pointed to involvement of the cerebellum, a diagnosis was made of a tumour of or adjacent to the cerebellum, and treatment was advised accordingly. Subsequent review of the whole case showed that probably the more correct interpretation of the clinical features was as follows. The general symptoms were the result of increased intracranial tension above the tentorium as the result of hydrocephalus. The cerebellar signs were the result of secondary pressure upon the contents of the posterior fossa, and not to direct involvement of or pressure upon the cerebellum by the tumour itself. It is true that the diffuse gliosis of the pons was adjacent to the cerebellum, but it was not of such a character as to produce the cerebellar signs by direct pressure. The cerebellar signs were, in fact, false localizing signs secondary to the internal hydrocephalus and not true localizing signs. The case raises the question of the value of the localizing signs present, and of the correct interpretation of the so-called general symptoms of intracranial tumour.

Case 2 was that of a girl, age 4 years, who had been unable to walk for eighteen months and had had ataxia of the lower limbs only during that time. Because of the poor mentality of the parents certain important points in the history of the child were wanting. On examination the child was found to have an unusually large head, optic atrophy on both sides, varying signs of involvement of the pyramidal tracts, and ataxia of the lower limbs. Throughout the illness the mentality of the child was perfectly good, and excepting for a period of one week when she was unusually drowsy there were no symptoms directly suggesting the presence of an intracranial tumour. The conditions to be considered in diagnosis appeared to be a degenerative condition involving the pyramidal and cerebellar tracts, a chronic inflammatory condition involving these tracts and the optic radiations, and the effects of a previously undetected hydrocephalus. The congenital form of hydrocephalus was excluded because the development of the child had been apparently normal in every respect up to the age of 3 years, and the acquired form because there was no history of an inflammatory condition within the skull. With a view to clearing up the problem ventriculography was carried out. Internal hydrocephalus was proved to be present, but the cause of it was still unexplained. The alarming symptoms of the child immediately after the injection of air into the lateral ventricles and her sudden death some hours later raised the question of the advisability of performing ventriculography in such cases, of the best method to be employed, and of the cause of the accidents which sometimes attend this procedure. Subsequently autopsy showed that internal hydrocephalus was present, and was the result of

obstruction to the outflow of cerebrospinal fluid by a tumour of the inferior part of the cerebellum. In addition to the points in connection with ventriculography mentioned above, this case raised the question of differential diagnosis in the presence of hydrocephalus, and of the importance of a detailed history in the presence of this complication.

Case 3 was that of a patient, age 45, who had suffered from a nervous breakdown, loss of energy, mental irritability, an increasingly poor memory, headache, and vomiting for eight months. On examination the only physical signs present were inequality of the pupils, doubtful constriction of the visual fields, a slight increase in muscle tone on the right side of the body, and bilateral papilloedema more obvious on the left side. The general symptoms seemed to point to the presence of an intracranial tumour, and the abnormal mental state suggested that it was in the frontal lobe ; while the difference in the muscle tone on the two sides with tremor and clumsiness of the right arm seemed to be in favour of a localization in the left frontal lobe rather than in the right. A decompression operation was consequently done over the left fronto-parietal region, and the patient died two days later of a subdural haemorrhage. The autopsy revealed the presence of dilatation of the lateral ventricles more pronounced on the left side than on the right caused by a tumour of the upper part of the midbrain and the septum pellucidum. This case again raised the question of the significance of the general symptoms of intracranial tumour, and of the localizing value of the symptoms and signs usually thought to be associated with lesions of the frontal lobes. The indefinite localizing signs present in this case were again false localizing signs produced by secondary hydrocephalus.

Case 4 was an example of secondary hydrocephalus due to the vicious circle set up by a tumour so situated that it could not directly block the circulation of the cerebrospinal fluid. A patient who had been increasingly drowsy for three weeks and had shown mental symptoms for a few days was admitted in a state of coma. Following admission a number of interesting points were noted in connection with the clinical features : (1) The limbs of the right side were stiff, and there was some retraction of the head, but as the coma increased the limbs showed alternating flaccidity and rigidity, and finally became completely flaccid. (2) In the early stages the reflexes were all increased, but as the coma deepened they became less active and control of the organic reflexes was lost. (3) When the pulse-rate was 68 and the temperature subnormal the urine was perfectly normal ; but, as signs of bulbar paralysis appeared, the temperature rose and glucose and acetone appeared in the urine. A further interesting point was the fact that a tumour, which must have been developing in a silent area of the brain for a long period, suddenly gave signs of increased intracranial tension, probably from indirect pressure on the medulla, and produced a fatal result within three weeks of the first indication of the presence of an intracranial condition. In this case prompt recognition of the presence of secondary hydrocephalus and adequate treatment of that condition could have led to the complete removal of the tumour itself. In addition to the points mentioned in connection with the previous cases, this case shows that secondary hydrocephalus due to a tumour not directly obstructing the circulation of cerebrospinal fluid

can arise *de novo* ; it also raises the question of the significance of glycosuria as a symptom in cases passing into coma with only papilloedema to indicate that increased intracranial tension is present.

Case 5 was that of a patient who had bitemporal headache and pain in the back of the neck for two months. In addition the speech was progressively defective, and walking was becoming more and more unsteady. The signs of increased intracranial tension were present—namely, vomiting and papilloedema. The clinical features of the case at the time, not described in detail in this paper, appeared to point to a tumour of the frontal lobe as the cause of the symptoms ; but, in view of the indefinite localization of the lesion and the urgency of the general symptoms, measures were adopted to relieve the increased intracranial tension. At the autopsy there was found a central tumour of the cerebellum obstructing the circulation of the cerebrospinal fluid and producing internal hydrocephalus. In this case the signs of a cerebellar lesion were apparently so indefinite, those of increased intracranial pressure so definite, and those of a lesion of the frontal lobe so suggestive, that a diagnosis was made of a frontal rather than of a cerebellar tumour. Closer attention to the sequence of events might have shown that the difficulty with speech and the impairment of gait were present from the onset of the clinical history, whereas the general symptoms were late in appearing and comparatively slow in developing—a sequence which would have suggested that more attention should be paid to the symptoms of a lesion of the posterior fossa, even though they were apparently indefinite. The physical signs which appeared after the two operations cannot be included in this discussion, as it is probable that they were, in some measure at least, dependent upon pressure effects in the neighbourhood of the operation areas. This case suggests, therefore, that in the presence of secondary hydrocephalus it is essential to make a careful study of the order in which the various symptoms and signs have developed, even in cases in which they are indefinite, in order to distinguish true and false localizing signs.

Case 6 was an example of a patient who had a quiescent arachnoid cyst of the cerebellum which finally produced secondary hydrocephalus. The chief points of interest in the case are the absence of symptoms of the focal lesion, and the slight indications of involvement of the pyramidal tracts apparently resulting from the secondary hydrocephalus alone.

Case 7 was that of a patient who had been affected since early infancy, and in consequence the clinical findings closely resembled those of the congenital form of hydrocephalus. At the age of 5 months he had been diagnosed as suffering from primary optic atrophy. From that age until three months before death the clinical picture was that of a slight degree of congenital hydrocephalus. At that time he had a sudden attack of headache, vomiting, and vertigo, after which he was unable to walk, and trembling of the hands and knees appeared. At that stage there appeared certain physical signs which indicated that there was a lesion involving the midbrain, and it was also recognized that the changes in the optic discs were characteristic of secondary and not of primary optic atrophy. At the autopsy there were found changes characteristic of secondary hydrocephalus involving the third and the lateral ventricles ; also a tumour mass in the floor of the third

ventricle and obstructing the circulation of the cerebrospinal fluid below that level. The remarkable feature of the case was that, apart from the optic atrophy, there were no general symptoms of increased intracranial pressure for over five years, while definite localizing signs of the tumour appeared only after the increase in intracranial pressure had been present for that time. The case illustrates the similarity of the clinical features of secondary hydrocephalus arising as the result of a tumour in infancy to those of congenital hydrocephalus; also the adaptation of the skull of the child to the increasing pressure to such a degree that, apart from the optic atrophy and the impairment of vision, no general symptoms of increased intracranial pressure were present except during the short attack three months before death.

VI. SECONDARY HYDROCEPHALUS AS A FACTOR IN DIAGNOSIS.

The symptomatology of secondary hydrocephalus *per se* would appear to be much more extensive than is usually thought. In general that of acquired hydrocephalus differs considerably from that of the congenital form of the disease. When, however, the condition arises very early in infancy or even in early childhood, as in *Cases* 2 and 7, it may closely imitate the congenital form. Enlargement of the head, a cracked-pot sound on percussion, and separation of the sutures may be present in secondary hydrocephalus which has begun in early childhood.

The statement frequently quoted in text-books that the symptoms of hydrocephalus caused by brain tumour are essentially those of the underlying condition is apt to be misunderstood. It would probably be more correct to say that cases of cerebral tumour, both those in which focal signs have been present and those in which they have been absent, are liable to develop symptoms of secondary hydrocephalus. In the former group the appearance of focal symptoms followed by general symptoms at once leads to the correct diagnosis of an intracranial tumour; but in the latter group such a diagnosis would be purely presumptive. Conditions other than an intracranial tumour may lead to the development of an intracranial state which produces all the general symptoms present in cases of tumour. These general symptoms—headache, vomiting, vertigo, and increasing papilloedema—are essentially the symptoms of increased intracranial tension, and those which may occur with secondary hydrocephalus from any cause. Each of them alone may be present as a result of increased intracranial tension, or as a symptom of other conditions to be referred to later.

When localizing symptoms *appear after the development of general symptoms*, they may be either *true* or *false* localizing signs, and a careful review of the clinical features of the case is necessary in order to estimate their true value in diagnosis. Such false localizing signs may be: general constriction of the visual fields, paralysis of lateral deviation of the eyeballs on one or both sides, mental symptoms suggesting a lesion of the frontal lobe, unilateral or bilateral symptoms suggesting slight interference with the pyramidal and sometimes the cerebellar tracts, symptoms and signs suggesting a lesion of the cerebellum, signs of pituitary dysfunction, unilateral or bilateral deafness, and tinnitus.

It is evident, therefore, that in the presence of the general symptoms of intracranial tumour arising *de novo* it is unsafe to diagnose an intracranial tumour on them alone without further investigation to determine the cause of the increase in intracranial tension; and, further, that it is unsafe to rely upon localizing symptoms which have developed subsequently in making such a diagnosis and in localizing the lesion unless they are beyond all doubt and are supported by other signs which place the lesion in the same position.

The differential diagnosis in a case showing the general symptoms which may be present with secondary hydrocephalus is a matter of some importance. Souttar[7] has stressed the importance of the differential diagnosis in cases associated with increased intracranial tension from such general conditions as renal disease, severe anæmia, and lead poisoning. In cases in which the tumour is placed in the frontal lobe and there is pressure either direct or indirect on the medulla, the differential diagnosis from diabetes mellitus may cause difficulty. In *Case* 4 the only method of differentiation between diabetes mellitus and increased intracranial tension during the later stages was the presence of papillœdema, and the same difficulty arose in connection with one of the cases reported by Bingel.[8] The cerebral form of disseminated sclerosis, in which retrobulbar neuritis is placed so far forward as to involve the optic disc, may cause difficulty in some cases; while the rare cases of papillœdema with transverse myelitis may cause confusion when the condition of the optic disc appears before that of the cord. Such general conditions are, however, readily excluded by a careful general examination of the patient.

Once it has been established that the general symptoms are the result of increased intracranial tension, it is necessary to decide whether they are due to massive tumour growth, œdema of the brain, general circulatory changes, or internal hydrocephalus. In those cases in which one or more localizing signs have been followed by the general symptoms of increased intracranial tension, a satisfactory working diagnosis is usually made at this stage, and, according to Russell Brain,[6] the presence of hydrocephalus may be suggested by early and frequent vomiting and the rapid development of papillœdema. When, however, there have been no localizing symptoms before the onset of general symptoms and the presence of secondary hydrocephalus is suspected, the problem is to prove that it is present, to determine the site of the lesion, to give a reasonable opinion as to its nature, and to advise the correct treatment. Ventriculography is, as a rule, the most useful method available for establishing the diagnosis and localizing the lesion; but it is not always advisable to use it. Penfield[9] recommends that this method should be avoided when there is much increased intracranial tension, but goes on to say that if the diagnosis of increased intracranial tension is certain, "air injection is of the greatest assistance and should prevent many negative explorations: it should therefore be used without hesitation in such cases" with the object of demonstrating the presence or absence of a tumour, and of determining the size and position of the ventricles. Grant[10] states that in 392 cases examined by ventriculography, that method of examination was of value in localization in 311 (79·3 per cent); while in 93 cases (23·0 per cent of the total) the lesion was localized on ventriculography alone. *Of the latter,* 44 cases (11·2 per cent of the total, or 40·0 per cent of the 93 cases) were

amenable to surgical treatment—figures which dispose of the idea that it is only the deep-seated inoperable tumours which are identified by ventriculography alone.

Having decided that a blockage to the outflow of cerebrospinal fluid is present, it is necessary in view of the treatment to be adopted to decide what is the cause of the blockage. Dandy and Blackfan[11, 12] showed that hydrocephalus might be : (1) Obstructive, due to congenital malformation, an inflammatory process, or to a tumour in any part of the ventricular system, but usually at the aqueduct of Sylvius, the foramen of Magendie, or the foramina of Luschka ; or (2) Communicating, due to a barrier of adhesions at the base of the brain preventing the cerebrospinal fluid circulating through the cerebral subarachnoid space. Such adhesions are usually the result of meningitis occurring either before or after birth, and frequently so mild as to be overlooked. This was pointed out by Hilton and of later years by Fraser and Dandy,[13, 14] who stressed the fact that not only post-inflammatory adhesions in the cisterna magna, but also congenital maldevelopment of the subarachnoid space, tumour of the brain-stem, and abscess in the same region acted similarly. Young[15] reported a case in which the clinical history was very suggestive of brain tumour, but in which hydrocephalus was present and disappeared after eight years. In some of the cases of hydrocephalus developing as a result of the above conditions a detailed history may be of considerable value in determining the presence of post-meningitic adhesions or abscess, while a history of focal symptoms before the development of general symptoms may serve to establish a tumour as the cause of the blockage. But when all the clinical methods have been employed there will still remain a proportion of cases in which there is no clue to the nature of the condition, and it is in these that the use of ventriculography is particularly necessary if the patient is to have his chance.

The risk of withholding this method of examination is much greater than that of using it, and, in view of Grant's[10] figures, it seems perfectly justifiable to use it even in face of the apparent risks in order to diagnose and localize the proportion of lesions which are amenable to surgical treatment in such cases.

VII. SECONDARY HYDROCEPHALUS AS A FACTOR IN LOCALIZATION.

It has been pointed out above that all localizing symptoms which develop after the appearance of general symptoms of increased intracranial pressure must be regarded with suspicion ; and that they may be used for localizing the lesion only if they are clear and unmistakable evidences of a focal lesion.

Of these false localizing signs, those suggesting involvement of the cerebellum are probably the most common. Nystagmus, hypotonia, intention tremor, and other symptoms of a cerebellar lesion may be present. They were present in *Case* 1, but were never sufficiently definite to make a diagnosis of a cerebellar lesion on them alone. They have been referred to by other writers. In Young's[15] patient fine nystagmus on lateral deviation, hypotonia of the limbs, and intention tremor were present, and disappeared on the

recovery of the patient. Two more definite cases were reported by Bramwell, [16, 17] both of internal hydrocephalus in which cerebellar signs were pronounced—in one of them the result of posterior basilar meningitis and in the other the result of obstruction at the foramen of Magendie by adhesions. Spiller[18] recorded a case of hydrocephalus with cerebellar signs in which at autopsy only hydrocephalus due to obstruction and closure of the aqueduct of Sylvius was found. Oppenheim[19] recognized the close association of the clinical signs of brain tumour and internal hydrocephalus in two cases, in one of which cerebellar signs were present, and at autopsy only internal hydrocephalus was found. Rhein[20] reported a case with cerebellar signs in which there were cystic dilatations of the lateral recesses of the fourth ventricle in the neighbourhood of the cerebellopontine angle. These examples of cerebellar signs appearing in cases of hydrocephalus are sufficient to show that, under such conditions, cerebellar signs which are not absolutely definite and develop with or after the appearance of general symptoms of increased intracranial tension are false localizing signs, and, as such, are of no value whatever in determining the site of the lesion.

In *Case* 3 the symptoms were strongly suggestive of a lesion of the frontal lobe of the brain. For eight months the patient had had a 'nervous breakdown', and had suffered from headache, vomiting, irritability, loss of memory, and loss of energy. On examination it was found that her mental condition was facile, there was a certain degree of euphoria, the recent memory was defective, and the facetiousness and jocularity or 'Witzelsucht' mentioned by Oppenheim and other writers was very definite. There was no focal lesion whatever present in the frontal lobes, and it was evident that the internal hydrocephalus was entirely responsible for the symptoms mentioned. Russell Brain[6] mentions mental deterioration and irritability as common symptoms of cerebral tumour complicated by hydrocephalus, and stated that in one case dysphasia was present. Though never very definite as localizing signs of a frontal lobe lesion, it is obvious that such symptoms must always, in the presence of unmistakable evidence of increased intracranial tension, be looked upon with suspicion and regarded as false localizing signs.

In this case the erroneous localization in the frontal lobe was supported in some measure by the fact that there were slight indications of involvement of one pyramidal tract, probably, as it proved, because one foramen of Monro was obstructed before the other and the corresponding lateral ventricle more distended than that on the other side. Though in this case the signs were quite indefinite, it is apparent that minor signs of a pyramidal lesion, upon which in obscure cases much reliance is apt to be placed in the attempt to determine the side of the lesion, may also be false localizing signs as a result of secondary hydrocephalus. Similar signs were also present in *Case* 6. The indications of a lesion of one pyramidal tract were more definite in one of the cases reported by Oppenheim.[19] In this case there were bilateral optic atrophy, contracture of the sternomastoid and trapezius, weakness of the left leg, an extensor plantar reflex on the right side, and exaggerated deep reflexes. Russell Brain[6] also includes involvement of the pyramidal tracts as a result of hydrocephalus and characterized by weakness, spasticity, and bilateral extensor responses as a feature of hydrocephalus complicating brain tumour.

Signs of pituitary dysfunction may appear in the course of long-standing hydrocephalus and lead to the suspicion that the pituitary gland is primarily at fault. In *Case* 1 concentric contraction of the visual fields was present even before the signs of papillœdema were evident. In *Case* 2 the child had become unusually obese since the onset of the illness, during which internal hydrocephalus had evidently been present for from eighteen months to two years. In *Case* 3 there was again, as far as could be determined, definite concentric contraction of the visual fields—a finding which led to the suspicion at one stage that a suprasellar tumour might be the cause of the symptoms. In this case, however, the position of the tumour suggested that the contraction of the visual fields might not be due entirely to hydrocephalus, but *Case* 1 suggested that the contraction might be due to the hydrocephalus alone. More definite accounts of the occurrence of the signs of pituitary lesions in the course of hydrocephalus have been recorded in the literature. Jacobaeus[21] reported the case of a female, age 20 years, who suffered from dystrophia adiposogenitalis, and had choked discs and other signs of increased intracranial tension. By means of ventriculography the diagnosis of hydrocephalus was established, and at the autopsy it was found that the only pathological condition present was internal hydrocephalus due to absolute obstruction of a chronic inflammatory nature in the aqueduct of Sylvius. In Young's[15] patient, at the age of 16, after hydrocephalus had been present for eight years, the weight was 162 lb., the sugar tolerance was slightly increased with a raised threshold, and the skiagram showed the presence of hydrocephalus and an enlarged sella turcica. Cushing[22] reported several cases in which hydrocephalus was associated with posterior-lobe insufficiency, and one in which there were acromegalic features. Marienesco and Goldstein[23] reported two cases of hydrocephalus with adiposity of the female type and genital hypoplasia, one with a cyst of the cerebellum and the other of unknown etiology. Kurt Goldstein[24] reported three cases of hydrocephalus in which changes in the sella turcica were noted together with obesity and under-developed genitalia; and similar cases have been reported by Stumpf,[25] Pollock,[26] Strauch,[27] and Schultz.[28] In Russell Brain's[6] 60 cases of cerebral tumour there were two which showed adiposity and infantilism of the Frölich type. It is evident, therefore, that in recent cases of hydrocephalus with headache, vomiting, vertigo, and papillœdema, the presence of bilateral constriction of the visual fields may lead to the erroneous conclusion that a suprasellar tumour is responsible for the condition; and that, in cases of longer standing, the signs usually associated with pituitary dysfunction, including changes in the sella turcica itself, may appear probably as a result of constant pressure on the hypothalamic region and the infundibulum.

Bilateral deafness was present in *Case* 2 and has been associated with tinnitus in several cases observed by us. In *Case* 2, in particular, it was found necessary to exclude the possibility of an intracranial complication of middle-ear disease before considering other explanations of the patient's condition.

Thus cerebellar signs, evidence of lesions in the frontal lobe, changes in the visual fields, minor signs of involvement of the pyramidal tracts, and signs of pituitary dysfunction and chiefly hypofunction, minor or fully-developed according to the duration of the condition, may appear in the

course of secondary hydrocephalus due to obstruction to the outflow of cerebrospinal fluid from any cause. Certain other signs occurring in the course of hydrocephalus and liable to be interpreted as localizing signs will be mentioned in the account of the clinical investigation of the condition. These signs are false localizing signs and, in cases in which the diagnosis of internal hydrocephalus is established or even suspected on the symptoms present, must be carefully considered and their time relations to the general symptoms determined before they can be used in the localization of the primary lesion.

VIII. THE INVESTIGATION OF SECONDARY HYDROCEPHALUS AND THE RESULTS OBTAINED.

The investigation of a case in which secondary hydrocephalus may be present is carried out by : (1) *Clinical methods—that is, a careful and detailed examination of the central nervous system ;* (2) *Puncture methods, including lumbar puncture, cisternal puncture, and ventricular puncture ;* (3) *X-ray examination ;* (4) *Ventriculography ; and* (5) *Observations made at the time of the operation.* These methods of examination are considered in turn, the clinical features which may be present in association with secondary hydrocephalus are described both as regards their value as symptoms of the condition and in relation to the possibility of confusion with those of focal lesions, and the indications both for and against the more technical methods of examination are detailed.

1. CLINICAL METHODS.

The symptoms of secondary hydrocephalus may appear secondary to those of a local lesion of the brain or of the cranial cavity, or may arise *de novo* in a patient who has been previously in good health. The chief symptoms of secondary hydrocephalus are essentially those which are usually regarded as the general symptoms of a cerebral tumour. They are primarily the symptoms of increased intracranial tension and may be due to conditions other than hydrocephalus. There are, however, certain symptoms and signs which appear earlier or more frequently in the presence of hydrocephalus, and serve in some measure to differentiate that condition from the other causes of increased intracranial tension.

The general symptoms of secondary hydrocephalus are well known. Headache is probably the most frequent symptom, but its severity depends upon the rapidity with which the obstruction to the circulation of the cerebrospinal fluid develops, and upon the non-yielding character or otherwise of the skull itself. After it has once appeared it seldom disappears completely, though it is subject to considerable fluctuations. It is usually described by the patient as a dull ache, or more often as a dull sense of pressure within the head, associated with a slight sense of physical ill-being or nausea which prevents him fixing his attention upon any occupation or recreation for any length of time. It is varied at times by acute exacerbations, during which the patient prefers to lie still and resents being disturbed. During these exacerbations it is aggravated by visual or auditory stimulation, or by anything which tends to increase the intracranial tension even for a

short time, such as stooping, running, coughing, or straining. It is frequently increased when the vomiting is most severe, probably for the same reason. The severity of the headache and the frequency and intensity of the exacerbations depend upon the rapidity with which the hydrocephalus develops. When developing suddenly in an adult the pain may be agonizing until some obscuring of the mental faculties appears. When developing in a young child, as in *Cases* 2 and 7, there may be nothing more than a feeling of malaise, sometimes associated with vomiting and vertigo, for a week or more, and then the child is again apparently well. The particular incidence of the acute exacerbations during the night and on awakening in the morning has not, in our experience, been definite enough to be of any value in diagnosis. Russell Brain,[6] however, states that in his cases the headache was especially severe at these times, and explains that this particular incidence is due to the fact that the blood-pressure, and consequently the intracranial pressure, falls during sleep and rises again in the latter part of the night and on awakening.

Vertigo is often associated with the headache, and, in our experience, has been more frequent in the presence of hydrocephalus than of œdema of the brain or circulatory changes complicating intracranial tumour. It is not a true vertigo of the type usually associated with cerebellar or labyrinthine dysfunction. It is rather a light-headedness or a swimming in the head, and is often described by the patient as such. It gives him the feeling that he is uncertain of his position, that he must be careful how he moves his limbs or where he puts his feet if he is to avoid falling ; and causes him to look for support when he attempts to move from place to place. Of staggering from side to side, or a tendency to fall in one direction or the other, there is usually little evidence until minor cerebellar symptoms develop as a result of direct pressure from above the tentorium. These symptoms will be discussed at a later stage.

Vomiting is a frequent symptom which also varies with the rapidity of the onset and is subject to exacerbations and remissions. In the adult it is usually most severe at the times when the headache is severe. Russell Brain[6] points out that it may be due to hydrocephalus alone, and, rejecting the explanation that it may be due to pressure on the medulla or to irritation of the vagus, believes it to be a reflex act of which the appropriate stimulus is a rise in the intraventricular tension. The vomiting is apt to be more frequent and more severe when the patient assumes the erect position, but at such times can often be lessened if the change in position is made gradually. It may or may not be preceded by extreme nausea, but it is often more frequent and more severe in those patients who complain of a constant feeling of nausea. It is usually an early and severe symptom of secondary hydrocephalus, and is often of great importance in drawing attention to the onset of the condition. In a young child, however, in whom the skull may adapt itself to the increase in pressure, it may be present for only a short time and then disappear (*see Cases* 2 and 7).

Transient disturbances of vision are generally present. These are usually the appearance of spots in front of the eyes, sudden dimness or transient loss of vision, a blurred outline to objects, and a feeling that a dark wall is shutting the patient in on each side. They are often associated with exacerbations of

the headache and vertigo, and appear on changing the position or on sudden movement. The acuity of the vision is, as a rule, unimpaired at first; but the patient is often unwilling to do anything requiring the use of the eyes, as he feels that it will aggravate his general symptoms.

Mental symptoms of all degrees may appear quite apart from involvement of any particular part of the brain, and are apt to be confused with those which arise as a result of a focal lesion in the frontal lobe. Loss of energy and a constant feeling of fatigue are frequent symptoms in those patients in whom the hydrocephalus has developed slowly (*Case 3*). There may be mental irritability for a time, but, as a rule, inability to concentrate and to maintain attention are the important features. The memory is often defective, that for recent events is particularly affected, but later the remote memory and the time relations of past events are usually confused. There is increasing inability to carry on an occupation or to attend to any duties, and consequently such patients are often *misunderstood or thought to be* suffering from a 'nervous breakdown' before the true condition is discovered. Such misunderstanding is apt to arise when the symptoms develop slowly (*Case 3*), but does not occur when more characteristic symptoms of increased intracranial tension develop rapidly (*Case 1*). The confusion of hydrocephalus with a lesion of the frontal lobe is often increased by the presence of an unnatural friendliness or a characteristic euphoria on the part of the patient. He may talk easily but wander from one subject to another, may show complete mental detachment, utterly disregard his physical condition, and, far from being disturbed by it, may feel and show others that he is capable of performing even the most difficult tasks. In fact, he may show all the symptoms usually associated with early dementia paralytica. A prominent symptom in one of our patients was a tendency to jocularity in every word that was spoken; and in two of them an unnatural willingness to have anything done to them as long as it was done quickly. Papilloedema, euphoria, and a steppage gait, all of which disappeared after decompression of the posterior fossa, were associated with dilatation of the ventricles without a tumour of the frontal lobe in a man of 40 referred to by Laignel-Lavastine and Cl. Vincent.[29] In some patients stupor is more obvious, especially when, for the time being, the intracranial tension is above the usual level. In one patient stupor always disappeared on the removal of a small quantity of cerebrospinal fluid, but recurred after sixty hours. As the pressure increases, the patient becomes more stuporose and may sink into a coma.

Generalized convulsions are distinctly unusual in the course of secondary hydrocephalus. They are mentioned by Russell Brain[6] as a symptom of hydrocephalus complicating cerebral tumour. It would appear that, with the increase in intracranial tension, the tendency to the release of function or the irritation of motor cells is lessened rather than increased, and it has been observed in cases of hydrocephalus supervening on a focal lesion characterized by convulsive seizures that the tendency to attacks diminished as the pressure increased. On the other hand, in certain cases, notably that of Gordon,[30] seizures have been present with an increase in pressure, and have become less frequent or disappeared on the relief of pressure.

The temperature is usually regarded as subnormal when the intracranial

tension is increased, but there are many exceptions to this rule. In three patients in whom a sudden increase in intraventricular tension had occurred, one of them following ventriculography, a sudden rise of temperature to 104° was observed, and in none of them could any other cause of the rise be found. It is possible that the rise in temperature in these cases is comparable with that which often follows intraventricular hæmorrhage. In one of our patients an inexplicable symptom was a subjective feeling of chilliness which had been present from the onset of the condition.

The pulse-rate is usually normal, and it is only in the terminal stages when the patient is sinking into coma that a slowing of the rate occurs. The respiration-rate does not appear to be appreciably affected during the active stage of the condition before indications of direct pressure upon the contents of the posterior fossa have appeared.

In short, there appears to be some justification for arriving at the following conclusions about the symptoms as opposed to the physical signs of uncomplicated secondary hydrocephalus: (1) When of sudden onset, the characteristic symptoms of increased intracranial tension appear rapidly in a severe form. (2) When of slow onset, more general symptoms such as those of mental changes may be present and symptoms of increased intracranial tension be less severe. (3) When developing in a young child, minor symptoms may appear for a short time and then disappear as the skull adapts itself to the increased pressure.

In addition to the symptoms, the physical signs of intracranial conditions are varied considerably by the presence of secondary hydrocephalus, and these variations appear not only in the form of alterations in motor power and reflexes, but also in the form of false localizing signs. The former group is best considered in the order in which the variations are encountered in the course of routine physical examination.

In the adult the skull presents no abnormality in shape or size, but occasionally some hyperalgesia of the scalp or tenderness on light percussion of the skull is present. This hyperalgesia is, as a rule, present generally over the vault of the skull, but occasionally it is confined to one side or the other or to the nape of the neck. In the young child the condition of the skull is that seen in the congenital form of hydrocephalus, and there may be great difficulty, apart from the history, in deciding whether a congenital or an acquired condition is responsible for the hydrocephalus (*Case 7*). The skull is enlarged and its circumference may approximate closely to that of the chest even in a child of 4 years, but, owing to the fact that facial structures have had a full opportunity of developing, there is not the same overhanging appearance of the forehead seen in the congenital form. Whether the sutures and fontanelles are affected depends upon the age at which the condition began. In *Case* 2 they were closed, in *Case* 7 they were represented by membranous tissue. The hyperalgesia and tenderness sometimes present in adult cases are usually absent. A cracked-pot sound may be present on percussion if the increase in pressure has been of long enough duration to thin the bones of the cranial vault.

The examination of the eyes presents many features of interest. Defective lateral deviation of the eyeballs may be present on one or both sides

entirely as a result of the general increase in pressure; and, associated with this sign, there may be transient diplopia and slight, irregular jerking movements of the eyeballs on looking to one side or the other at command, but not sufficiently definite to be classed as true nystagmus. The vision is good in the early stages, but when diminished, as it often is as the condition progresses, should lead to the suspicion that optic atrophy is already developing. In the early stages the retinal veins are often distended. The margins of the optic discs may be blurred and papilloedema develops rapidly. In the course of two or three weeks it may reach 5 dioptres and be associated with small hæmorrhages into the retina around the disc margins. If the condition persists or the increased intracranial tension is unrelieved, secondary optic atrophy rapidly develops, with failure of vision, pallor of the optic discs, obliteration of the physical cup, blurred disc margins, increase in pigment around the margins of the discs, and the presence of visible lymphatic sheaths along the vessels close to the disc. The appearance of papilloedema on one side and not on the other, or a greater degree of swelling on one side, does not necessarily indicate that the lateral ventricle on that side is distended more than that on the other side. In connection with this point, however, a comparison of *Cases* 1 and 3 is instructive.

Deafness and tinnitus may be present. There may be noises in the head which the patient describes as like the sound of a waterfall, preventing him hearing properly. Beyond a slight tendency to a lack of expression of the face in repose, the other cranial nerves are usually unaffected. Quite apart from the lack of co-operation due to the impairment of the patient's mental state, all types of sensation may be appreciated somewhat less readily than by the normal individual.

In the absence of evidence of involvement of the motor paths, the muscle tone is often reduced, motor power is slightly decreased, and the tendon reflexes are less active than normal. Cases have been observed in which it was impossible to elicit the tendon reflexes on one side, while on the other they could be elicited only because there was slight involvement of the corresponding pyramidal tract. The plantar reflexes are flexor, or great difficulty is experienced in eliciting any response; occasionally they are found to be extensor. There may be a slight, irregular tremor on one or both sides, but the cause of this sign is not at all evident. The tremor may, however, be confused with that which sometimes occurs with lesions of the frontal lobe, and has been suggested as a useful sign in localization in such cases. Beyond a slight unsteadiness in movement, both with the eyes open and with them closed, co-ordination is usually fairly good.

When the condition is severe and producing mental impairment, or when it has been present for a long time, there may be intermittent or permanent incontinence of fæces and urine. It was particularly noticeable in one case how lack of control of the sphincters appeared as the pressure increased, while complete control resulted as soon as the pressure was relieved.

The more definite false localizing signs which sometimes appear in cases of secondary hydrocephalus have already been referred to in discussing the condition as a factor in localization. The signs which suggest slight involvement of the cerebellum are particularly important, and may occur on one side

more than on the other or equally on the two sides. As a rule, however, these signs are rarely as definite as those which occur with a focal lesion of the cerebellum ; nevertheless they are sufficiently suggestive in a case in which localization depends upon minor indications to be a source of confusion. More definite vertigo is present, the gait is often reeling, and the patient may feel a tendency to fall backwards or to one side. Nystagmus may be more definite, the speech may be slightly slurred, and the muscles of the limbs hypotonic. The motor power in the limbs is decreased, the tendon reflexes are more difficult to elicit, but vary from time to time, there may be some tremor of the hands on movement towards an object, a slight rebound phenomenon may be present, there may be a suggestion of decomposition of movements, and slight spontaneous deviation of the hands may occasionally be apparent. It will be recognized that, when occurring bilaterally, these signs are simply suggestive of cerebellar dysfunction and no more ; but when occurring on one side more than on the other, it will be obvious that they will lead to difficulties in a case in which one is forced to depend upon minor variations in attempting to localize the lesion. In *Case* 1 they were present more on the left side than on the right. Nystagmus was definite with a long, slow swing to the left, there was a tendency to fall back and to the left, there was a tremor of the left hand on movement, the slight rebound defect was more obvious on the left side than on the right, there was slight spontaneous deviation of the left hand to the left, and the tendon reflexes were more difficult to elicit on the left side than on the right—all signs which suggested, but were not definitely diagnostic of, a lesion of the left side of the cerebellum. As, in this case, the main pontine lesion was very small and did not exert any direct pressure upon the cerebellum, it was evident that the symptoms depended largely upon the secondary hydrocephalus present. There was one feature, however, which may serve to distinguish between primary and secondary cerebellar signs—namely, that the signs varied from day to day and would be definite one day and absent the next, an extreme variability of signs which is not usually observed in true cerebellar lesions.

The mental symptoms which may suggest a lesion of the frontal lobe have already been referred to earlier in this discussion. Minor indications of a pyramidal lesion may appear on one or both sides, and it would seem that they are more likely to arise when the development of the hydrocephalus has been rapid. Some increase in the muscle tone of the limbs may appear together with an increase in the deep reflexes as compared with the normal for the patient. When such slight variations occur more on one side than on the other, or on one side only, it appears that the signs correspond to a greater distension of the lateral ventricle on the opposite side. These signs are comparable with the general muscular rigidity, sometimes more definite on one side than on the other, which may occur with intraventricular hæmorrhage, and are probably less obvious because of the slower rate of development (*Case* 4). Cases have been seen in which more definite indications, such as inequality of the abdominal reflexes and a transient extensor plantar reflex, were present. The evidences of dyspituitarism developing in the course of secondary hydrocephalus are particularly interesting, but it is evident that they are liable to occur only in those cases of gradual onset and of comparatively long duration.

2. PUNCTURE METHODS.

The puncture methods which may be employed in the investigation of secondary hydrocephalus are lumbar puncture, ventricular puncture, and ventricular puncture with estimation of the position and volume of the lateral ventricles. Cisternal puncture is rarely, if ever, used, except incidentally, in the investigation of this condition.

As a rule the cerebrospinal fluid withdrawn by lumbar puncture shows no abnormality, but if there is a complete obstruction of the communicating channels between the lateral ventricles and the spinal subarachnoid space, very little fluid may be obtained by this means. In *Case* 1 the cerebrospinal fluid was normal except for the following Lange curve—0021000000. In *Case* 3 the cerebrospinal fluid was again negative and produced the same Lange curve. In *Case* 2 at the first examination there were 4 'small lymphocytes' per c.mm., the Lange test was negative, and the protein was unusually low (0·0075 per cent). At a subsequent examination, there were 8 'small lymphocytes' per c.mm., the protein was again low (0·006 per cent), and there was a slight excess of globulin. On this occasion the Lange curve was the same as that in *Case* 1. In *Case* 6 the cerebrospinal fluid was normal; while in *Case* 4 it was not under pressure, was clear, contained 10 lymphocytes per c.mm., and 0·1 per cent of protein.

Beyond noting that in *Case* 3 the fluid withdrawn from the ventricles showed no increase in cells and was unusually poor in protein, we have had no opportunity of investigating the condition of the fluid withdrawn from the ventricles.

It is possible that direct ventricular puncture with the measurement of the pressure of the fluid in one or both lateral ventricles, and a comparison of the intraventricular pressure with that obtained on lumbar puncture or cisternal puncture, may serve to establish the presence of a block in the circulation of the cerebrospinal fluid between the two ventricles, between the ventricles and the spinal subarachnoid space, or between the ventricles and the cisterna magna. Dandy[31] has employed an ingenious method of ventricular estimation for the localization of brain tumours in comatose patients. He taps both lateral ventricles and estimates their size and position. If both are dilated and they are in communication as shown by indigo-carmine, he concludes that the tumour is in the posterior fossa and explores in that region. If one is dilated and the other collapsed, he explores on the side of the collapsed ventricle.

It is evident, therefore, that, apart from the information to be obtained by ventricular estimation, the examination of a patient suffering from secondary hydrocephalus by puncture methods usually produces evidence of a negative character.

3. X-RAY EXAMINATION.

As a rule in the adult case a skiagram gives little information of value apart from the evidence of increased vascularity in the neighbourhood of a meningeal tumour or endothelioma. In the cases which have begun in early childhood, however, the enlargement of the cranial vault may be confirmed. thinning of the bones of the vault may be noted, the bones may present a

beaten silver appearance, and accentuation of the vascular grooves may be apparent. The last-named feature may also be noted in adult skulls if the intracranial pressure has remained high for a long period.

Certain changes in the base of the skull may be seen in cases of long standing, and especially in those associated with pituitary dysfunction. Decrease in the overhanging clinoid processes, flattening of the sella turcica from above down, and even enlargement of the cavity itself may be present. The possibility that such changes as these may be present in cases of secondary hydrocephalus in association with symptoms of pituitary dysfunction, constriction of the visual fields, and papilloedema is of importance in diagnosis and localization, for a group of findings of this nature is likely to suggest that a lesion of the pituitary gland itself or of the suprasellar region is entirely responsible for the clinical picture, whereas the occurrence of pituitary dysfunction and changes in the sella turcica secondary to hydrocephalus may be overlooked. It would appear that these changes are brought about by direct pressure either from within or without the gland, for the wide dilatation of the infundibulum itself would suggest that pressure may be exerted from within the gland as well as from without.

Irrespective of the relation of intracranial tumours to secondary hydrocephalus, Cairns[32] has pointed out the value of X-ray examination in the diagnosis and localization of such tumours. The presence of calcification in 71 per cent of craniopharyngeal pouch cysts according to McKenzie and Sosman,[33] the positive radiological findings in 'meningiomata' described by Sosman and Putnam,[34] evidence of calcification in 10 per cent of gliomata according to Van Dessel,[35] and evidence of displacement of the falx cerebri or of the pineal body to one side of the middle line by noting the position of shadows of calcified areas in one or the other, show how X-ray examination may be of considerable value in the diagnosis and localization of the lesions giving rise to secondary hydrocephalus.

4. VENTRICULOGRAPHY.

Having reached the stage in the investigation of a case in which a tumour is suspected to be present and possibly complicated by secondary hydrocephalus, it is necessary to decide whether ventriculography should be employed to confirm the diagnosis and, if possible, to localize the responsible lesion. This resolves itself into the consideration of the indications for and against employing the method, the technique of the method to be used, the sites of puncture, the positions in which the head is to be photographed, and the interpretation of the films themselves.

It cannot be denied that this method of examination exposes the patient to certain risks, and these must be carefully considered and weighed against the condition of the patient and the value of the information that may be gained. In Case 2, towards the end of the operation, the breathing became stertorous, vomiting occurred, and the patient went into coma ; she recovered after the further withdrawal of a small quantity of cerebrospinal fluid, was apparently normal though somewhat drowsy for four hours, then became cyanosed and died suddenly. Though it was apparent from the condition of the patient that sudden death might have occurred at any time, it cannot

be doubted that the operation contributed to her death. In another case. about three hours after the operation, the patient complained of severe head-ache and vomited frequently, the temperature rose rapidly, and retention of urine necessitating catheterization occurred. It was only after the use of methods directed towards the temporary relief of increased intracranial tension that this patient's condition returned to normal. In the 392 cases collected by Grant[10] death was directly attributable to ventriculography in 32 cases. Of the 37 cases investigated by ventriculography in Cushing's clinic and referred to by Cairns,[32] 2 died as a direct result of this procedure, and serious symptoms were produced in a third. In one case urgent symptoms appeared one and a half hours after the operation as a result of a great increase in the intracranial pressure, and in another serious symptoms appeared only at the end of three days. Penfield[9] reported a case in which severe headache followed by sudden death occurred thirty-six hours after the operation in a patient in whom the ventriculogram had shown the presence of secondary hydrocephalus. Bingel[8] collected the reports of 6 cases of death following the introduction of air by the spinal route, and of 3 cases in which the ventricular route had been employed. In 7 of these cases there had been ventricular block, in 5 as the result of a tumour above the tentorium, and in 2 owing to a subtentorial tumour. In 2 of Denk's[36] cases included in the above series air was introduced by the lumbar route and death occurred after a long interval.

· Penfield[9] has discussed the dangers of ventriculography other than the risk of sudden death or of death at an interval after the operation. In 50 per cent of his cases there occurred a moderate febrile reaction, consisting of a rise of temperature within twenty-four hours and lasting up to four days. Increased intracranial tension with vomiting, drowsiness, and increased head-ache for as long as one week were present in some cases. Vomiting and rapid coma persisting for one hour supervened in one case in which the lumbar route was employed, and was thought to be due to the collection of air in the subarachnoid space and around the medulla. Penfield mentioned that this type of reaction did not occur in cases in which the ventricular route was employed, but our Case 2 provides an example of this reaction under those circumstances. Coma and convulsions occurred in one case and disappeared in four hours after the removal of the air from the ventricles. Frequently. staining of the cerebrospinal fluid with blood was noted towards the end of the operation, probably as the result of a meningeal reaction. This reaction was also mentioned by Hermann[37] and by Mader.[38] The former found 18,000 and 11,000 cells in the fluid at the time of a second puncture, and the latter noted that with successive withdrawals of fluid the percentage of lymphocytes steadily increased. Penfield reported one remarkable case of infection of the ventricles during the operation. Herniation of the cerebellum into the foramen magnum was particularly apt to occur if an increase in intracranial tension was already present; and bulbar paralysis, coming on quickly and disappearing in a short time, was liable to occur especially when the lumbar route was employed. A slow increase in intracranial pressure with vomiting. headache, and drowsiness occurred in some cases in which the ventricular route was employed, but in such cases sudden death might result. Penfield

pointed out that, in the presence of ventricular block, an increase in the intra-ventricular pressure usually occurred an hour or two hours after the puncture and the introduction of air, and the pressure had been found to be definitely higher at the time of a second puncture than when the injection was just finished. He suggested that this post-operative increase in pressure might be due either to the irritating action of the air or to the sudden reduction of pressure during the operation stimulating an increased production of cerebro-spinal fluid. In 20 infants in whom air was injected by the lumbar route Mader[38] observed a constant reaction—the child cried, then became quiet and pale, vomiting and changes in the pulse occurred, and in the more severe cases respiration ceased.

From the consideration of these reactions following ventriculography, it will be obvious that they are sufficiently frequent and severe to suggest that this method of examination should be used only when a definite diagnosis and localization is not possible by other means. The clinical results of diagnosis and localization vary with different individuals and the necessity for ventriculography varies in consequence. It is equally obvious, however, from Grant's figures that it should be used without hesitation in those cases in which the general symptoms are definite, not only to determine the size and position of the ventricles and to determine the presence or absence of a tumour, but also to decide whether exploration or an attempt at surgical removal is likely to meet with success. It definitely increases the proportion of cases of intracranial tumour in which surgical intervention is possible, and at the same time reduces the number of negative explorations. In some quarters, however, ventricular estimation according to the method recommended by Dandy[31] is preferred to ventriculography as being the safer procedure.

Certain procedures have been recommended for dealing with the reactions which are apt to follow ventricular puncture and ventriculography. Of these, the most practicable appear to be the following : (1) The replacement of cerebrospinal fluid by air should be carried out gradually and with only gradual alterations in pressure—that is, the fluid should be withdrawn in very small amounts and replaced with air at each stage. (2) If an unfavourable reaction should occur during the operation, the air should be removed and replaced by Ringer's solution or the previously removed cerebrospinal fluid. As, however, dangerous reactions are liable to occur when a large quantity of fluid is still present. it may be possible only to remove a further small quantity of fluid in an attempt to relieve the symptoms. (3) As the air injected can always occupy a larger volume than the fluid removed, the volume of air injected should always be less than that of the fluid removed. (4) When ventricular block has been shown to be present, it is necessary to anticipate the subsequent rise of pressure within the ventricles by the use of hypertonic saline intravenously, or a saline cathartic by the mouth or rectum. (5) In cases in which ventricular block is suspected the patient may be subjected to decompression immediately the condition is diagnosed and within two hours of the injection of air into the ventricles. The decom-pression operation may be carried out either as an operation in itself or as the first stage of a subsequent attempt at removal if the case is suitable.

According to Grant, early operation will remove the risk of all the severe after-effects of ventriculography.

The choice of the method to be employed in injecting air for ventriculography in cases of suspected secondary hydrocephalus needs some consideration, and resolves itself into a discussion of the relative advantages and disadvantages of the direct ventricular and of the lumbar route. Of the latter method we have had no experience, but reference to the literature on the subject would appear to point to a very definite choice between the two procedures. According to Penfield,[9] bulbar paralysis, a slow increase in pressure resulting in sudden death, and herniation of the cerebellum into the foramen magnum are more liable to take place when the lumbar route is used. According to Mader,[38] the injection of air by the lumbar route in infants resulted in severe reactions in every case, and in death in one case; whence it was concluded that the spinal route should be used only with great care. Of the nine deaths after ventriculography recorded by Bingel,[8] six occurred after lumbar injection. Denk's[36] three fatal cases were all the result of injection of air by the lumbar route, whereas he had carried out thirty injections by the ventricular route without any serious difficulty. Denk concluded therefore that the injection of air by the lumbar route was never justified in the presence of increased pressure unless preceded by a ventricular decompressive puncture. Jacobaeus[21] apparently favoured the ventricular route in preference to the lumbar route, recognized that it was probably of more value in diagnosis, and drew attention to the possible use of cerebral puncture as a therapeutic agent. Waggoner,[39] basing his opinion on an analysis of ten cases, preferred the spinal route for the purpose of obtaining a roentgengraphic record of the ventricles, cisternæ, and the subarachnoid spaces, and pointed out that it was particularly valuable in the differentiation of the obstructive and communicating types of hydrocephalus.

Opinions differ as to the most suitable site for ventricular puncture. Grant[40] recommends that the site of puncture should be 7 cm. above the occipital protuberance and 1·5 cm. lateral to the middle line, and claims that this site has the following advantages : (1) The site of puncture allows the needle to pass through a silent area of the brain. (2) A puncture at this site permits a direct approach to the vestibule of the lateral ventricle, which is its widest part and that least likely to be collapsed. (3) With the head back, efficient drainage of the ventricles can be obtained. Dandy recommends the occipital route in order to avoid the possibility of hæmorrhage into a cerebral tumour, as a tumour in that region can be ruled out by a careful chart of the visual fields. Others again advise puncture of the inferior horn of the lateral ventricle through an opening 1·5 in. above Reid's base line and the same distance behind the external auditory meatus.

According to the majority of writers, the most important factor for success in ventriculography is the removal of all fluid ; but equal stress is laid upon the removal of the fluid and the replacement with air in small amounts at a time, and upon the introduction of a volume of air less than that of the fluid removed. It is essential that antero-posterior, postero-anterior, right lateral, and left lateral skiagrams should be taken, and if possible

stereoscopic skiagrams. Great care must be exercised to keep the head perfectly still while the exposure is being made if a good outline of the ventricular system is to be obtained. In the antero-posterior skiagrams it is essential that the head is kept absolutely in the middle line, otherwise some distortion of one or other ventricles may occur and false deductions be made.

In the interpretation of the ventriculograms much experience of both the normal and abnormal features of the ventricles is needed. Normal variations are not at all uncommon, especially in the lateral ventricles, as has been shown by Penfield.[9]

In general, intracranial tumours produce either symmetrical or asymmetrical variations in the position, shape, and size of the ventricles. The asymmetrical variations are due either to a tumour within the cerebral hemisphere and lateral to the middle line, or to direct impingement of a tumour on the lateral ventricle, and not to obstruction of or interference with the free circulation of the cerebrospinal fluid. Tumours in the region of the foramen of Monro may be partially or completely blocking that opening, and a unilateral hydrocephalus may be produced which can readily be demonstrated in an antero-posterior skiagram. Tumours in the occipital lobe may obliterate the descending horn of the lateral ventricle, evidence of which can be seen in a lateral skiagram, especially if stereoscopic views be taken. In the same way large tumours of the frontal lobe may exert enough pressure almost to obliterate the descending horn of the lateral ventricle, and so produce an irregularity in the outline of a lateral skiagram. As a general rule it may be said that asymmetry of the lateral ventricles is strong evidence of a cerebral tumour on the side of the small ventricle.

Excepting for the rare cases in which a tumour of the midbrain obstructs the outflow of cerebrospinal fluid from one lateral ventricle to a less extent than from the other, obstruction of the free circulation of the cerebrospinal fluid usually results in a more or less symmetrical dilatation of the two lateral ventricles, and may be produced by a tumour in the mid-line between the two hemispheres, by one involving the foramen of Monro or the third ventricle, or by one blocking the outflow of fluid in the aqueduct of Sylvius, the fourth ventricle, or the cistern. If it be accepted that a subtentorial decompression is essential in the case of subtentorial tumours—a question which will be discussed at a later stage—it is necessary to differentiate carefully between a supratentorial and a subtentorial tumour in the region of the third ventricle. It has been suggested that two useful points of differentiation are the following : (1) If the third ventricle can be seen, the block is below the tentorium ; and (2) A subtentorial tumour to one side of the middle line may impinge upon the posterior horn of the lateral ventricle and distort it. Elsberg and Silbert[41] have added the following interesting point of differentiation : that a block above the tentorium distends the anterior and inferior horns of the lateral ventricle equally, whereas one below the tentorium distends the former more than the latter.

Generally it is found that the antero-posterior and postero-anterior views are the most valuable, but in arriving at a conclusion on the ventriculograms it is essential to consider only the defects which are present in all the views, and to correlate the results with the clinical findings.

In some cases there can be no doubt that ventricular estimation may take the place of ventriculography, and it is a safer procedure. In this operation the lateral ventricles are tapped and the amount of fluid withdrawn from each is noted. Any amount over 30 c.c. points to a condition of hydrocephalus, and if the amounts from the two ventricles are not the same it is strong evidence of a tumour above the tentorium.

5. OBSERVATIONS AT THE TIME OF OPERATION.

Observations made at the time of operation, and especially in the course of operation for mobilization of the tentorium, are useful in confirming a diagnosis of secondary hydrocephalus. The cerebral hemispheres are found to be tense and firm to palpation, the gyri are flattened, and the superficial veins are distended. If the pressure is high, the dura and the brain tissue are forced into the wound on removing the bone-flap. Distension on one side more than on the other may help to localize the cause of the obstruction in the midbrain or between the two cerebral hemispheres, obstructing the circulation of fluid from one lateral ventricle more than from the other; while a collapse of the ventricle on one side associated with dilatation on the other side suggests a tumour involving the cerebral hemisphere on the collapsed side. Equal distension of the two ventricles suggests that a midbrain tumour has obstructed both foramina of Monro, or that the tumour causing the block is at a lower level.

In addition, observations of the tenseness of the cerebral hemispheres during lumbar puncture after the bone-flap has been removed may show that no decrease in pressure occurs with the removal of fluid from the spinal canal, and confirm the opinion that a block exists in the hindbrain.

IX. THE TREATMENT OF SECONDARY HYDROCEPHALUS.

The effect of the presence of secondary hydrocephalus upon the treatment to be employed would appear to be the following. Measures designed to facilitate the absorption of cerebrospinal fluid, such as the intravenous injection of hypertonic saline solution or the use of magnesium sulphate by the mouth or the rectum, may be necessary as a preliminary step. We must state, however, that we have never seen any prolonged benefit from repeated enemata of concentrated magnesium sulphate, nor from the use of hypertonic saline intravenously. These measures have been used successfully to carry a patient over the danger period, such as that due to the sudden increase in intracranial pressure after ventriculography.

Following such preliminary urgent treatment, surgical methods of relieving the increased intracranial tension are necessary. Repeated ventricular puncture may be considered, but it would appear that this method is likely to be of value only in those cases in which time is necessary for a local inflammatory or obstructive lesion to recover. It was used successfully in a case reported by Gordon.[30]

When surgical decompression is considered, it has to be decided whether decompression above or below the tentorium should be employed, even when there are some indications that the cause of the blockage is in the posterior

fossa of the skull. Each case has to be considered on its merits, but the balance of evidence would appear to be in favour of a supratentorial decompression in association with exploration of the posterior fossa. The general principle would appear to be to attack general symptoms above the tentorium and only definite localizing symptoms below the tentorium, and, when necessary, to combine both objects in one operation.

The treatment of secondary hydrocephalus is, therefore, the removal of the tumour wherever possible, but this is rarely possible, more particularly when the tumour cannot be localized. The treatment where the tumour cannot be removed is simply that of decompression. The intermusculo-temporal decompression gives quite good results and considerable temporary relief. For cases in which the tumour is subtentorial the best results are obtained by turning down an osteoplastic flap, and exposing the occipital lobes and the cerebellar hemispheres by means of Souttar's craniotome. The constriction of the tentorium at once becomes loose, as the tentorium no longer has its bony attachment behind the occipital bone.

X. SUMMARY AND CONCLUSIONS.

1. The influence of secondary hydrocephalus upon the diagnosis and localization of intracranial tumours is discussed, and the methods of investigation and treatment are detailed.

2. The different views propounded to explain the occurrence of hydrocephalus in the course of intracranial tumours are reviewed.

3. Seven cases of intracranial tumour complicated by secondary hydrocephalus are described to illustrate the difficulties in diagnosis and localization in the presence of secondary hydrocephalus.

4. The differential diagnosis of intracranial tumour complicated by secondary hydrocephalus is discussed.

5. Secondary hydrocephalus as a source of confusion in localization is considered ; attention is drawn to the false localizing signs which may appear as a result of that condition ; and stress is laid upon the chronological order of the physical signs.

6. The investigation of a case of secondary hydrocephalus is discussed ; the clinical features of the condition are described, and the value of puncture methods, X-ray examination, ventriculography, and observations at the time of operation are considered.

7. Ventriculography should be employed in the investigation of a case only when all other methods of examination have failed to establish a diagnosis and to localize the lesion ; and, in carrying out this procedure, ventricular puncture is to be preferred to spinal puncture.

8. In view of the questions raised in this paper, the treatment of secondary hydrocephalus should be instituted as early as possible commensurate with thorough investigation of the patient. It should provide for the relief of pressure above the tentorium even when the local lesion is situated in the posterior fossa of the skull—a result which is best achieved, when symptoms of a subtentorial lesion are present, by the operation for mobilization of the tentorium, as has been amply illustrated by some of Souttar's cases.

We are indebted to our colleagues on the staff of King's College Hospital and of the West End Hospital for Diseases of the Nervous System for permission to include cases under their care, and especially to Dr. W. E. Carnegie Dickson for detailed pathological reports on four of the cases described.

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VOLKMANN'S ISCHÆMIC CONTRACTURE TREATED BY TRANSPLANTATION OF THE INTERNAL EPICONDYLE.

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IN the BRITISH JOURNAL OF SURGERY, October, 1928, Hamilton Bailey recorded a case of Volkmann's ischæmic contracture treated by the transplantation of the internal epicondyle of the humerus. Stimulated by this
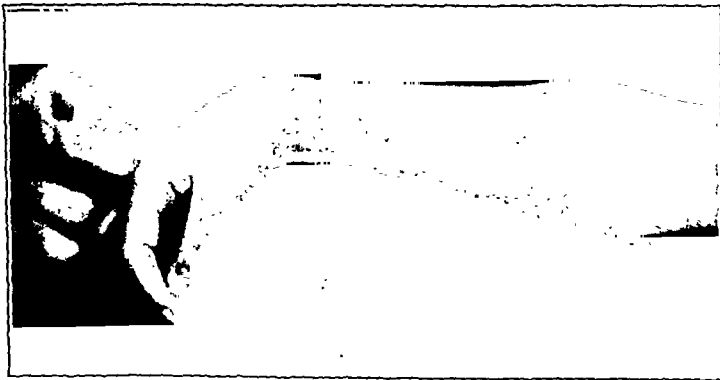
FIG. 171.

FIG. 172

article I determined to try the operation in a case which had hitherto resisted all efforts to overcome the contracture, and the result has far exceeded my expectations.

The case was one of a girl, age 14, who some eight years previously had sustained a fracture of the lower end of the right humerus. The method by which the fracture was treated could not be ascertained. When first seen four years ago she had a typical Volkmann's contracture. Gradual extension of the wrist, massage, and movement were tried over a long period, but the improvement made was negligible.

Figs. 171 and 172, made before the operation, show the flexion of the fingers when an attempt was made to extend the wrist, and that the fingers could only be extended by fully flexing the wrist.

FIG. 173.

In November, 1928, I carried out the operation on the lines described by Hamilton Bailey. My experience follows his exactly ; there was no dramatic relief of the contracture, but at the end of three weeks there was an appreciable improvement in the amount of extension obtainable. Massage and movement are being continued, together with gradual extension of the wrist on a 'cock-up' splint.

Fig. 173 shows the condition of the hand on Jan. 31, 1929. The patient has now good use of the fingers and wrist, and what was previously practically a useless member is now a useful limb. I hope that in the course of time still further extension of the wrist will be possible.

A FURTHER NOTE ON KÜMMELL'S DISEASE.

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As a sequel to our previous article on Kümmell's disease[1] we wish to place on record the pathological findings subsequently ascertained in one of the cases therein recorded. The present photograph (*Fig.* 174) refers to *Case* 7 in our previous account.

In March, 1925, he was kneeling, and was struck on the back by a falling stone. He was kept in bed for several weeks on account of pain and shock. X-ray examination at this time revealed no bony spinal lesion at the site of the injury. In the summer of 1925 he was up and about, much relieved, but still ~~~~~ ~~ ~ ~ : ~~ual soreness. He could walk abou ~~ ~ ~~ ~ ~ ~ . In October he complained of a great exacerbation of the dorsal pain. His back became very painful when he walked. Examination revealed several healed abrasions on the back and a kyphosis at the dorsilumbar junction. There was considerable local tenderness with much pain and limitation of movement at the level of the 1st lumbar vertebra. X-ray examination showed that this vertebral body was collapsed and had assumed a wedge shape typical of Kümmell's disease. The patient was thereupon fitted with a jacket giving spinal support. His symptoms regressed and his spinal lesion became stationary. In April, 1926, insanity, not relevant to Kümmell's disease, supervened and he was certified and removed to an asylum. Here his spinal lesion remained stationary for two years, and finally the spinal jacket became quite unnecessary, though the patient would never part with it.
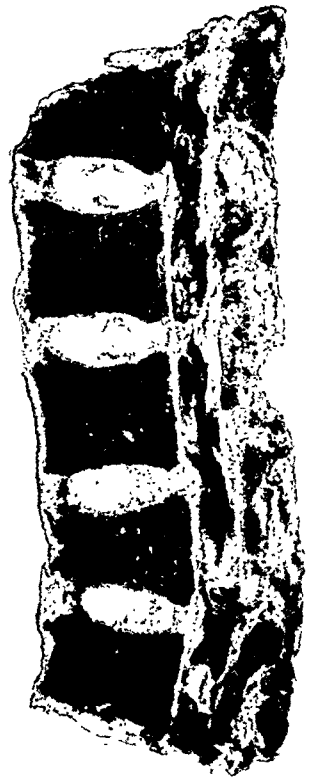
FIG. 174.

Sequel.—In September, 1928, the patient died, and by the courtesy of Professor Shaw Bolton his dorsilumbar spine was added to the collection of similar specimens in the Pathological Museum of the Leeds School of Medicine. The photograph (*Fig.* 174), which we think calls for no comment, shows the typical wedge-shape deformity and collapse of the 1st lumbar vertebra.

Recent authoritative literature,[2] notably from the original pen, has stabilized Kümmell's disease as a clinical entity. We do not propose to recapitulate our former article, but we would like to emphasize in the above case the characteristic salient features of the malady. The full sequence is : (1) An injury, direct or indirect, grave or trifling, to a vertebral body ; (2) A

period of disability according to the gravity of the trauma; (3) A latent period; (4) A recurrence of local pain and severe disability due to (5) A crumpling collapse of a selected vertebral body, and its assumption of a wedge shape as seen in sagittal section; (6) The arrest of the process by orthopædic support.

We are again indebted to Professor Maxwell Telling for permission to record this case.

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ON THE TRANSFUSION OF CITRATED OR DEFIBRINATED BLOOD THROUGH A FINE NEEDLE.

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BLOOD transfusion has developed from an emergency operation, confined to the operating theatre, into a routine mode of medication, which often has to be repeated at frequent intervals and be performed either in the ward of a hospital or at the home of the patient. Although many methods have been devised during the last ten years, there is yet a demand for a simple and reliable procedure which can be carried out at the bedside, without much assistance, with minimum discomfort both to the donor and to the recipient, and with success.

One of the first difficulties in performing a blood transfusion is to find a suitable donor. Now that the glamour of giving one's blood to a patient has largely died out, owing to the fact that blood transfusion is often used not as a desperate effort to save life but as a remedial measure, voluntary donors who are not related to the patient, and even professional donors, demand that no incision be made which needs sutures and subsequent dressings and which will leave a scar on the arm. The use of a needle, even of large bore, on the other hand, has proved to be unsatisfactory in many cases, as the flow of blood is never as good as when using a cannula; the flow may slow down after the first 200 to 300 c.c. and the blood may clot inside the needle, thus preventing any further collection of blood unless another vein is tapped with a fresh needle.

Dr. Herbert French has devised a 'needle' which is a cross between a cannula and an ordinary needle, having a point with three facets like a bayonet and a stem made to a conical shape so that the bore at the base is considerably greater than at the point. The needle is so sharp that it will pierce the skin like butter, it is easily introduced into a vein, and it ensures a splendid flow of blood, without risk of clotting. French's needle (*Fig.* 175 B) is connected directly to the jar for collecting blood (A) by thick rubber tubing which cannot kink, and there are no metal or glass connections between to cause friction or to hold up the flow of blood along its course, as the rubber tubing is threaded straight through the rubber bung of the jar. The blood flows by gravity, and it is neither necessary nor advisable to produce a vacuum inside the jar, as this tends to hinder the flow by collapsing the vein. There is no risk of contaminating the blood by holding the jar below the donor's arm, as the jar is closed by a rubber bung. A pint or more of blood is thus quickly drawn off, and on withdrawing the needle the small triangular wound like a leech bite soon closes and stops bleeding on lifting the arm above the head for a few minutes. There is no incision, no injury

to the vein, and the same vein may be used repeatedly for subsequent trans-
fusions.   It is not advisable, however, to use a donor more than twice for
the same patient, as the recipient becomes as it were sensitized to the blood.

The use of sodium citrate as an anticoagulant is the easiest way of trans-
fusing blood, although it is not always harmless.   Mellon[1] has shown the
variability of the chemical reaction of commercial sodium citrate, and there
is probably also an individual variation in the tolerance of different people.
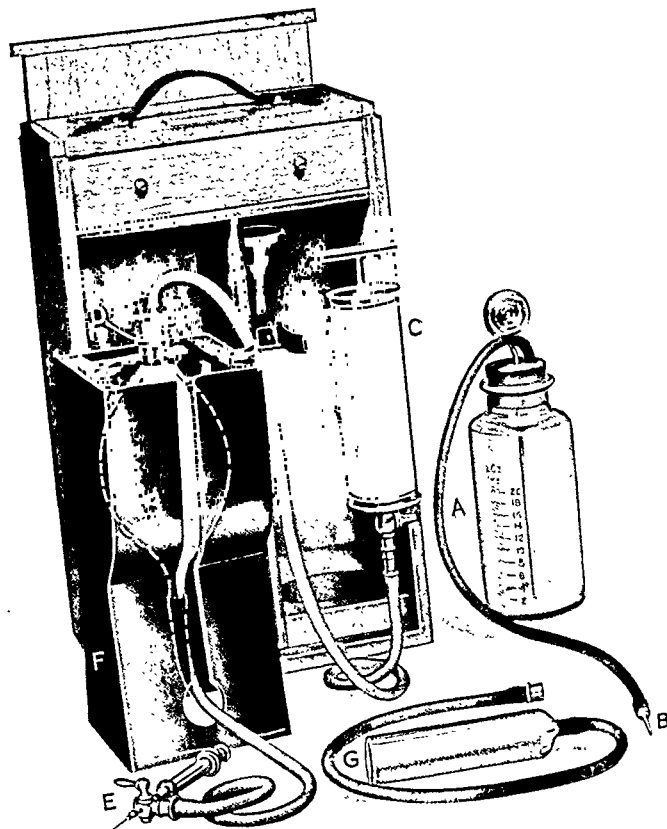
FIG. 175.—Diagram of the apparatus.   A, Graduated jar for collecting blood.   The
graduations are both in ounces and cubic centimetres.   The curved rod is used for defibrinating
the blood ; B, French's needle ; C, Pump ; D, Reservoir containing blood after having been
citrated or defibrinated and filtered ; E, Two-way stop-cock with hypodermic syringe, needle,
and tube from reservoir, all attached in readiness for use ; F, Heating stand with two
hot-water tanks on either side of the reservoir.   The reservoir may be taken out of the
stand ; G. Saline infusor.

Lederer[2] and others claim that the addition of sodium citrate increases the
incidence of reactions.   This drug, however, is not the only factor in pro-
ducing a post-transfusion reaction.   The reaction may in some cases be
anaphylactic, due to some sensitive protein in the donor's blood, or it may
be caused by slight incompatibility, especially when stock grouping rather
than direct testing of the donor's and recipient's blood is relied upon ; lastly

it may be due to incipient coagulative changes if the blood is not drawn off quickly enough and well filtered. Keynes,[3] while admitting the possible influence of citrated transfusions in causing reactions, regards their occurrence as of little importance and as greatly overweighed by the advantages of the method.

In view of these objections which may be made to the citrate method, the collecting jar (*Fig.* 175 A) in my apparatus has been adapted also for the defibrination method. When using the defibrination method, Skinner[4] has recommended the use of a special curved rod, which is inserted into the rubber bung with its curled end pointing downwards and touching the bottom of the jar. The jar is kept in a continuous rotary motion during the whole time the blood is being collected and for at least five minutes afterwards. Fibrin will collect in a lump on the curled end of the rod and can then be removed.

If the citrate method is used, the required amount of a freshly prepared and sterile solution of sodium citrate is poured into the collecting jar, and the central rod is inserted with its curled end pointing upwards. Opinions differ as to the strength of the solution to be used. I use the smallest amount of citrate sufficient to prevent clotting, or 10 c.c. of a 2 per cent solution to every 90 c.c. of blood, although some writers favour larger doses. Robertson[5] recommends 160 c.c. of a 3·8 per cent solution for 750 c.c. of blood as it gives an isotonic solution. Spriggs[6] uses a 4 per cent solution, of which 100 c.c. are added to each 500 c.c. of blood.

The citrated or defibrinated blood is decanted from the collecting jar (A) into the reservoir (D) and at the same time it is strained through two layers of gauze or cheese cloth. Prior to pouring the blood into the reservoir a small amount of normal saline is made to flow through the rubber tubing, the two-way stop-cock (*Fig.* 175 E and *Fig.* 176) and needle, in order to expel any air contained therein.

The reservoir (D) is placed in a heating stand (F) provided with two water tanks on either side to keep the blood warm. A chief difficulty in performing a blood transfusion is to deliver the blood to the recipient. The cannula method entails dissecting a vein to the discomfort of the patient, while if a needle of moderate bore is used, as suggested by methods described heretofore, there is always some anxiety in introducing the needle into the vein when the vein is small or contracted. In gravely exsanguinated or nervous patients the vein may be spastically contracted so as to make it impossible for the blood to flow into the vein after the needle has been inserted. In order to overcome these difficulties, I have introduced the use of very fine intravenous needles (size 21 Standard Wire Gauge), and this has been made possible by a specially devised pear-shaped container (D), a strong pump (C), and a two-way stop-cock (E). The pear-shaped container is connected to a pump, and the mouth of the container is closed by a rubber stopper which can be firmly fixed by two screw clips. By using a reservoir of this shape, practically all the blood can be pumped out under great pressure without any risk of blowing air into the vein. The pump is made to the same design as that used in a Potain's aspirator, but is three times larger and will enable blood to be pumped through a very fine needle.

Lastly a two-way stop-cock (*Fig.* 175 E and *Fig.* 176) has been devised which so simplifies the technique of delivering the blood to the recipient that this may be done as easily and with as little discomfort to the patient as any ordinary intravenous injection. To it an ordinary hypodermic syringe, a needle, and the tubing leading from the reservoir are attached. The tap of the stop-cock can be turned in such a way as to have either the syringe and needle communicating (*Fig.* 176 *a*), or the syringe cut off and the needle communicating with the tube from the reservoir (*Fig.* 176 *b*). With the tap turned to *a*, the operator introduces the needle into the vein, draws some of the recipient's blood into the syringe to ensure that the needle has been correctly inserted, thereupon turns the tap round to *b*, and rapidly connects the needle to the reservoir. In this way one eliminates the tedious procedure
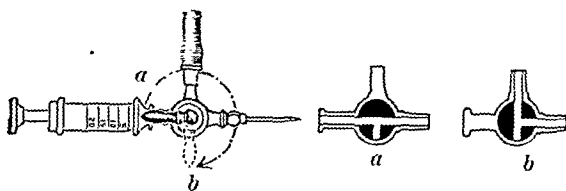
FIG. 176.—Diagram of the two-way stop-cock. *a.* The needle and syringe are communicating. *b.* The tube leading from the reservoir (*Fig.* 175 E) is now connected with the needle.

of fitting the tube on to the needle after the vein has been punctured, which often entails spilling of blood and a risk of air embolism, and the whole operation of inserting the needle and connecting it with the transfusion set is made perfectly easy and fool-proof. When the reservoir is nearly empty the tap of the stop-cock is turned back to *a*, thus shutting off the reservoir, and the needle is withdrawn from the vein. The small amount of blood left in the stem of the reservoir and in the rubber tubing is a sufficient safeguard against air being injected into the vein. It is not possible to overlook the fact that the reservoir has been emptied, as the heating stand has a slit-window exposing the whole length of the reservoir, and the flow of blood can be easily watched.

TECHNIQUE.

To Collect the Blood.—Pour the required amount of sterile 2 per cent solution of sodium citrate into the collecting jar. Place a sphygmomanometer armlet round the donor's arm, raise the pressure to 80, and instruct the donor to clasp and unclasp his fist alternately. With a quick jab introduce French's needle into a vein (median basilic or median cephalic) and allow the blood to flow into the jar by gravity.

When using the defibrination method insert the metal rod with its spiral end pointing downwards touching the bottom of the jar, and do not add any citrate. During the whole time the blood is being collected the bottle is kept constantly revolving gently, thereby swinging the blood content against the spiral. As soon as sufficient blood is obtained the needle is withdrawn and the bottle continuously rotated for about six minutes, at the end of which time the cork is removed; a large single clot of fibrin will be found adhering to the spiral. Before pouring the citrated or defibrinated blood into the reservoir precede with some sterile saline to expel any air in the rubber connections, and while decanting the blood from one jar to the other strain the blood through gauze or cheese cloth. Place the reservoir in the heating stand to keep the blood warm.

To Deliver the Blood.—Place a bandage round the recipient's arm so that it can be easily loosened as soon as the vein has been punctured. With the tap of the stop-cock turned to *a*, introduce the needle into a vein and draw some blood into the hypodermic syringe; if blood flows freely into the syringe it is sufficient proof that the needle has been correctly inserted. Turn the tap to *b*, thereby connecting the needle to the reservoir, loosen the bandage, start to pump, and blood will begin to flow into the vein. When the reservoir is nearly empty turn the tap back to *a* and withdraw the needle from the vein. It takes ten to twenty minutes to deliver a pint of blood, but if necessary the blood can be injected much more slowly.

The apparatus has been thoroughly tested in a large number of blood transfusions over a period of three years and can be strongly recommended. The technique is extremely simple and does not require any operative skill. The apparatus can be easily cleaned and sterilized and the whole set is obtained in a convenient box for carrying it. The transfusion set includes also a saline infusor composed of a cylindrical glass funnel with rubber tubing (*Fig.* 175 G) which can be connected to the two-way stop-cock and needle. The same procedure is followed as described for delivering blood, except that saline is poured into the funnel and allowed to flow into the vein by gravity. The saline infusor may be used for intravenous injection of normal saline, glucose, etc. The whole of my own apparatus, as described above, may be obtained from Messrs. Reynolds & Branson Ltd., of Leeds.

SUMMARY.

Difficulties arising from other methods of blood transfusion, described heretofore, afford a sufficient excuse for devising yet another apparatus having the following advantages :—

1. A very fine intravenous needle (size 21, I.S.W.G.) can be used for delivering blood to the recipient.

2. The operation of inserting the needle into the vein is simplified by a two-way stop-cock enabling the operator to ensure that the needle is correctly placed inside the vein and rapidly to connect the needle with the transfusion set by the mere turn of a tap.

3. There is no risk of clotting.

4. Either the citrate or the defibrination method may be used.

5. Blood transfusion can be carried out at the bedside, as there is very little need for asepsis.

6. Blood is kept warm in a heating stand.

7. The technique is extremely simple, does not require any operative skill, and ensures success every time.

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THE RADIUM PROBLEM.

I. INTRODUCTORY.

By Professor G. E. GASK, C.M.G., London.

The interest of the world of medicine and of the public at large has been stirred by the advances made in the last few years in the treatment of malignant disease by radium. The subject is of such pressing national importance that in April of this year the Radium Sub-Committee of the Committee of Civil Research issued a report on radium in the treatment of cancer, and the Government promised to make a grant of £1 for every £1 subscribed by the public for the establishment of a National Radium Fund, and this now amounts to a large sum. The ready response of the public to this appeal shows its practical interest, and it has been decided that the public contribution shall form part of the Thank-offering Fund for the King's convalescence. Subsequently two bodies were founded to deal with the fund—namely, the National Radium Trust and the National Radium Commission. As the result of this National Fund it is hoped that a large supply of radium will be forthcoming for the use of the medical profession in its campaign against cancer. It is well, therefore, that a survey should be made to consider the present position of radium in the treatment of malignant disease in order to assess its proper value, without either taking an exaggerated view of its therapeutic properties or underrating them.

It has been known for many years that radium has a powerful effect on various affections of the skin, and that rodent ulcer and superficial epitheliomata can often be completely and permanently cured by its use in surface applicators. During the last few years the technique of radium therapy has been elaborated and greatly improved by the use of radium needles, or of seeds containing radium emanation or radon, which are buried in the tissues in or around the growth. Most of the work done in this country has been directed towards the treatment of cancer of the cervix uteri, the rectum, the breast, and the tongue and buccal cavity. These areas have been selected by the various Research Centres, because in these situations growths are easily accessible and the effects of the radium can be seen and judged, whereas in internal cancers it is much more difficult to watch the effect of treatment. It can be stated definitely that in the above-mentioned areas, as the result of long and hard work, of many trials and many errors. a big step forward has been made. In many cases carcinomata of the cervix, breast, rectum, and mouth have entirely disappeared, and the patients remain well and apparently free from disease for several years.

It is astounding—indeed, almost miraculous—to observe the manner in which in a successful case a malignant growth fades and disappears. In one instance a well-marked epitheliomatous ulcer of the tongue disappeared and skinned over in the space of three weeks from the commencement of treatment. The nearest comparison that can be made is the manner in which a gummatous ulcer on the skin heals in a few weeks under appropriate treatment. This makes one wonder what is the action of radium on the growth. Does it kill the cancer cells ? One has seen the effect on the cells in Canti's film. Or does it kill the virus or active agent of cancer ? There is as yet no answer to this intriguing question.

Remarkable as are the results already obtained, we must not allow ourselves to run away with the idea that radium is the cure for all cancers, for the problem is not an easy one. The attack on the primary growth is, in a sense, the easiest part of the task, for if the growth is accessible, if the radium is implanted in the right place, if the whole of the tumour is irradiated, if the dose is correct, and if the exposure is rightly timed, then one may expect the shrinkage and disappearance of the tumour. In the course of the work one point that has come out quite clearly is that destruction of a primary growth, followed by its complete disappearance, does not in any way affect the growth and extension of metastases, if these are already formed, any more than excision of a carcinoma of the breast by the knife will cure a patient if there are secondary deposits in the viscera. Radium therapy, if it is to be successful, must aim at destroying not only the primary growth, but also any extensions which may have formed in the neighbouring lymphatic glands. We must emphasize again the fact that treatment of cancer, if it is to be successful, whether it takes the form of surgical excision, the cautery, radium, or X rays, must be undertaken early, before dissemination has occurred ; and it must be reiterated that an essential part of the campaign against cancer consists in the education and intelligent co-operation of the public so that early diagnosis and early treatment may be secured. Already something has been done in the direction of irradiating the lymphatic drainage area at the same time as the primary growth, as will be seen in the succeeding articles, and the prospects of improving this line of treatment appear to be good.

If one turns now to consider what is the relative value of radium therapy in the treatment of cancer as compared with surgical excision, it will be found a difficult point to assess, for the reason that there are not yet sufficient facts available. In the first place most of the available data concern cancer only of the areas of the body above mentioned, and secondly we have not yet a sufficient number of cases, nor has sufficient time elapsed, to prepare statistics which will show a true picture. The great point in favour of the use of radium is that the effect can be obtained without the extensive and mutilating operations which are at the same time so distressing to the patient and to the surgeon. The operation of introducing the radium is in itself a comparatively slight one, not fraught with any immediate danger, and while the radium is in position the patient suffers little or no discomfort. Under these conditions, and with bright hopes of cure without mutilation, patients are far more ready to consult their doctors with hope of relief, instead of hiding their tumours till it is too late for any form of radical treatment.

Against the use of radium, and in favour of surgical excision, must be placed the danger of leaving a portion of a cancerous growth non-irradiated, and of leaving infected lymphatic glands which might be removed by excision. The difficulty of arriving at the proper dose and exposure must also be reckoned. On the one hand the radiation may be too little; on the other hand it may be too much, resulting in burning or sloughing of tissues and the formation of obstinate and slow-healing ulcers. Last, but not least, there is the danger to the health of workers in radium. Radium is a double-edged weapon, as the pioneers in this form of therapy have found to their cost. The housing, staffing, and maintenance of a radium institute for surgical purposes require very careful management and supervision, and are therefore costly.

The above seems to be a long array of arguments against the use of radium, but a little consideration will show that most of the points raised may be overcome by care and forethought.

Most of the results achieved in this country have been by means of superficial applications, by buried needles, by radon seeds, or by the combination of these three methods. Little has been done in the radiation of tumours from a distance by large quantities of radium—that is, 4 or more grm. at a time. This is known as distance radium therapy, or more commonly as the 'bomb' treatment, because a large quantity of radium is placed in a container —the 'bomb'—and applied in such a way that the radium rays may penetrate the affected area. We have not had sufficient radium to do much in this way, but it is a method which urgently requires investigation.

The summary of the argument is that a good case has been made out for the employment of radium. Hope for the cure of cancer is bright. A new weapon and a powerful weapon has been placed in the hands of the medical profession, though just how good it is impossible to say as yet. Nor is it yet possible to say whether patients with malignant disease should be treated with radium alone, or with radium combined with surgery or with X rays. One would think it probable that a judicious use of them all may be required; but at any rate it seems clear that clinicians must be familiar with a use of all three methods.

What is required at the moment is work, intensive work, on the many problems which present themselves, combined with careful documentation of the methods used and registration of the results obtained. This calls for the co-operation of physicists, clinicians, radiologists, pathologists, and research workers. Some brilliant work has already been done, but much more requires to be accomplished before the story of radium can be told.

SHORT NOTES OF
RARE OR OBSCURE CASES

A CASE OF FIBROSARCOMA OF THE CERVICAL MENINGES.

By CECIL P. G. WAKELEY.

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INTRADURAL tumours of the cervical meninges are comparatively rare, and although such cases are seen and operated upon successfully, very few have been reported in this country. The following case is of interest as immediate relief followed operation, although the symptoms were of two years' standing.

HISTORY.—L. P., age 28, was admitted to King's College Hospital in May, 1923, under the care of Dr. Aldren Turner, complaining of unsteady gait and pains in his shoulder. The onset of his complaint took place two years before admission to hospital, when the patient noticed pain in his right forearm. This was at times so severe as to prevent him from sleeping, and it gradually extended from the forearm to the shoulder. He stated that any sudden movement of his neck caused him severe pain, and to prevent this he kept his neck constantly bent downwards towards his chest.

About one year prior to admission to hospital he noticed weakness in his right leg. This was thought to be of a rheumatic nature, for which his doctor prescribed a liniment. However, the weakness became more marked, and the patient was unable to walk without the aid of a stick. When walking he could only drag the right leg along, and found it impossible to lift it from the ground. In January, 1923, he contracted influenza, and was in bed for eight weeks. He had lost two stone in weight since the commencement of his illness. When he was able to get about again in March, 1923, he found it very difficult to walk, even with the assistance of two sticks. He also complained of weakness in the right hand.

ON EXAMINATION.—When seen in May, 1923, he was found to be a fairly well nourished man. The right arm was considerably thinner than the left, although he was right-handed at his work as a joiner. There was a difference of two inches in the circumference of the upper arm on the two sides. There was very little difference in the measurements of the lower extremities, although the right leg was slightly smaller than the left. There were no motor disturbances on the left side of the body, while on the right side there was a well-marked atrophy of the muscles of the thenar and hypothenar eminences. The interossei appeared to be completely paralysed, as the patient could not separate his fingers at all. There was definite weakness of the flexors and extensors of the fingers. He could only stand with difficulty, and always fell

forwards and towards the right when his eyes were closed. Nothing abnormal was discovered in the chest or abdomen. The pulse-rate was 80, the respirations were 18, and the blood-pressure was 140 in the brachial artery.

There was no paralysis of any of the cranial nerves. The pupils reacted well both to accommodation and light. The right pupil was thought to be slightly smaller than the left ; the fundi appeared normal. The knee- and ankle-jerks were increased on both sides, ankle clonus was very marked on
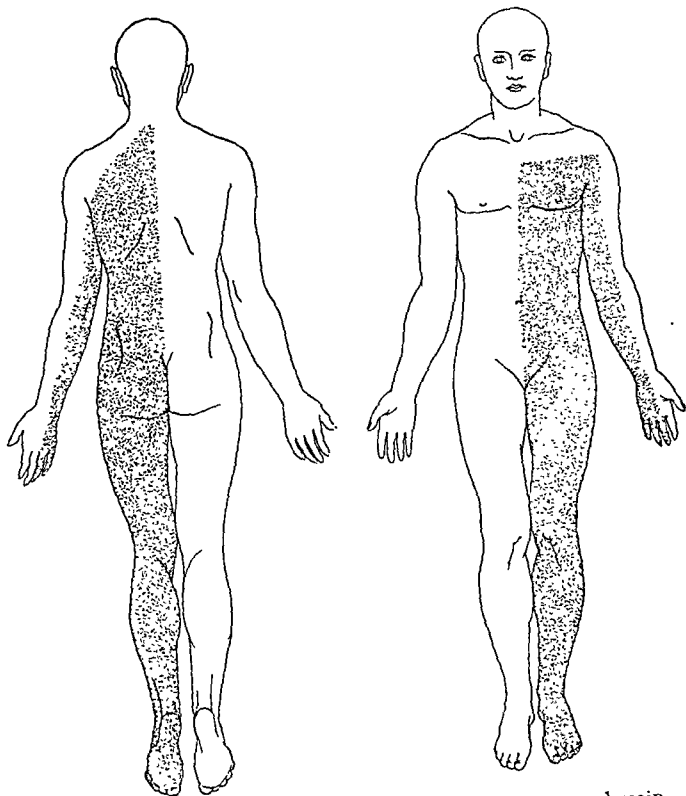
FIG. 177.—Showing areas of loss of perception to heat and pain.

the right side. The biceps- and triceps-jerks were increased in the right arm ; the abdominal reflexes were absent. With regard to sensory disturbance, there was no interference with the transmission of tactile impressions from either side of the body, but perception of heat and pain was lost over the whole of the left side from the level of the second intercostal space (*Fig.* 177).

There was no loss of muscle sense in the extremities.

Skiagrams of the cervical spine did not demonstrate any abnormality in the bones.

OPERATION.—Laminectomy was performed on May 10, under intratracheal ether anæsthesia. An incision was made as shown in *Fig.* 178, extending over the lower four cervical and upper two thoracic spinous processes. The spinous processes were bared of muscles and ligamentum nuchæ. The muscles were retracted by means of a self-retaining

FIG. 178.

laminectomy retractor. The spinous processes of the last cervical and upper two dorsal vertebræ were removed with bone-cutting forceps. The laminæ on each side were cut through with a laminectomy saw, and an intervening portion of bone was elevated by means of an osteotome and removed. There was very little extra-dural fatty tissue; the dura mater was seen to be distinctly tense, and there was a definite dilatation and tortuosity of the vessels on the posterior surface of the dura. A longitudinal incision was made into the dura just to one side of the mid-line, in order to avoid the largest longitudinal vessel on the surface of the dura. On opening the dura there was a sudden rush of cerebrospinal fluid, and an intradural tumour was seen lying on the right side of the cervical cord, causing definite compression. There were two nerve-roots in relation to the tumour,
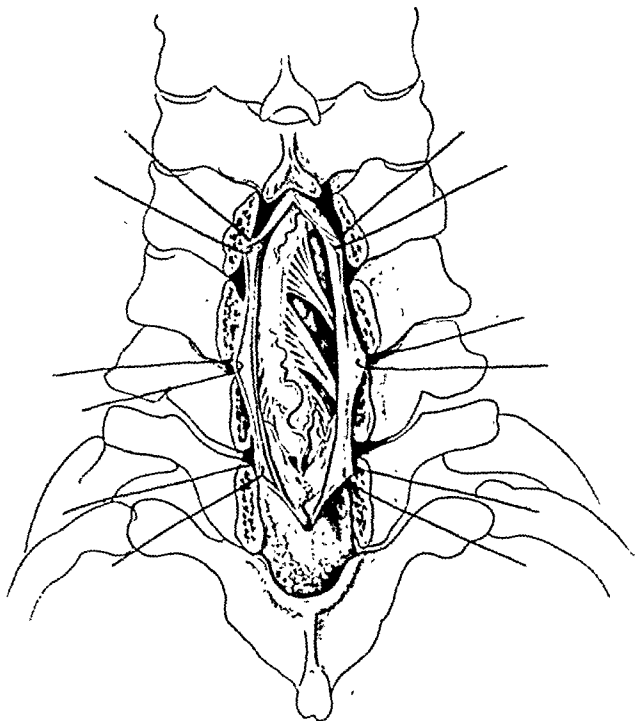
Fig. 179.—Diagrammatic drawing of tumour as seen after opening the dura mater.

acting more or less as anchors and keeping the tumour in position (*Fig.* 179). The two nerve-roots were carefully retracted, and the tumour bulged into the wound ; it could not be removed, however, as it was found to be attached to the dura mater opposite the 7th cervical vertebra. By means of a tenotomy knife the portion of dura mater adherent to the tumour was removed, together with the tumour (*Fig.* 180). There was not much loss of blood, and the blood-pressure was remarkably constant throughout the operation. At the commencement it was 160 ; it dropped to 100 when the dura was opened, but rose again so rapidly that when the patient left the operating theatre it was 150.

Fig. 180.—Appearance of tumour after removal. (× 2.)

The wound was irrigated gently with warm saline solution, and the dura mater was closed with interrupted catgut sutures. The spinal muscles were approximated with interrupted silkworm-gut sutures. A small drainage

tube was inserted down to the muscles, and the skin was closed with interrupted silkworm-gut sutures. Dressings were applied, but no support was used for the head. The patient was nursed lying flat on his back with his head between sand-bags for a week, after which time he was allowed to sit up. He was allowed to get up on the fifteenth day, and left hospital just three weeks after his operation. The wound healed *per primam intentionem*, the drainage tube having been removed after twenty-four hours.

The pathological report was as follows : " The tumour is a fibrosarcoma in which areas of hyaline degeneration can be seen."

AFTER-HISTORY.—Except for some shooting pains in the right arm there was no discomfort of any kind during convalescence. Motor power in the right leg gradually returned. Two days after the operation there was no field of anæsthesia to pain and temperature whatever.

The patient returned to hospital in October, 1928, to obtain a certificate for insuring his life, and I carefully examined him. There is practically no scar to be seen on the neck. There is equal muscular development and tone on both sides of the body, and no sensory loss in any part. It was really owing to seeing this patient again after five years, and finding him in such an excellent state of health, that I decided to publish the case.

COMMENT.

It is interesting to note that although operation was considered to be the right and proper treatment for tumours of the spinal cord by such men as Leyden, Erb, Byrom Bramwell, and Gowers, it was Horsley who first removed a tumour of the spinal cord on June 5, 1887. Since that date, which must be looked upon as the birthday of spinal-tumour surgery, many successful cases have been reported. Similar instances to the one here described have been reported by Sargent, Lennander, and Harvey Cushing.

The operative mortality of spinal-cord tumours is very low at the present day, while twenty years ago it was nearly 50 per cent. Harte, writing in 1905, stated that the operative mortality rate was 47 per cent, and De Martel, in 1910, recording his results in a series of 20 operations, had 9 deaths, a mortality rate of 45 per cent. From 1910 to the present time the operative mortality of tumours of the spinal cord has been getting smaller and smaller. In 1920 Sargent published a paper on his first 25 cases of spinal tumour ; his operative mortality was 20 per cent. He has kindly allowed me to quote his figures, which have just been brought up to date. In a total of 82 cases of tumours of the spinal cord there were 17 deaths. This mortality of 20·7 per cent includes all cases which died in hospital, some of which lived for a week or so after the operation.

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TWO CASES OF INTESTINAL OBSTRUCTION DUE TO STRANGULATION OF A LOOP OF SMALL INTESTINE IN AN OPENING OF THE LEFT BROAD LIGAMENT.

By ROBERT JANES,

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STRANGULATION of small intestine in an opening in the broad ligament seems to be very rare. A few cases of strangulation in pouches have been reported by C. H. Fagge[1] and B. H. Pidcock,[2] and one that I have been able to discover, through an opening in the ligament in the absence of a pouch, by H. A. Barr.[3] The number is so small that the addition of the following two case reports should be of value.

Case 1.—The first case was that of a married woman, age 58 years, who during the previous ten months had had repeated attacks of abdominal pain. These attacks had lasted from a few minutes to several hours, and had consisted of recurring severe cramps in the region of the navel. They occurred more frequently at night than in the daytime and were eased by walking about. On only one occasion had vomiting occurred. The last attack had begun twenty-four hours before admission to hospital, and had been much more severe than any experienced before; it had been accompanied by abdominal distension and repeated vomiting. There was symmetrical distension of the whole abdomen, which was slightly tender all over. A moderately tender, somewhat cystic mass was felt behind the uterus.

On entering the abdomen a coil of small intestine, 15 in. long, was found to have passed through a small opening in the left broad ligament. The bowel was distended, slightly œdematous, and tense. It entered the opening from in front and lay for the most part in the pouch of Douglas. The opening was a little less than 2 cm. in diameter and lay below the round ligament and Fallopian tube, immediately lateral to the uterine vessels. It was easily enlarged by the fingers, and the strangulated coil was then withdrawn. No sac was present. The margins of the opening were approximated with catgut and the abdomen was closed. Recovery was uneventful.

Case 2.—The second patient was a woman, age 36 years, the mother of seven children. Two or three months previously she had had an attack of abdominal pain which lasted one hour. Three days before operation she had developed severe crampy abdominal pain. In the first twelve hours this had remained severe in character and she had vomited two or three times. Since then there had been little or no pain, although the abdomen continued to feel sore. For a few hours before operation there had been some bloating and frequent vomiting. There was moderate general distension of the abdomen, which was tender in the left lower quadrant. The uterus was retroverted and freely movable, although movement caused some pain. There was tenderness in the left lateral fornix.

In spite of the presence of auricular fibrillation and a pulse-rate of 140 it was decided to open the abdomen. On exposing the intestine the ileum

FIG. 181.—*Case 2.* Showing the condition found at operation.

was found to be obstructed at about 18 in. from the ileocæcal junction. The obstruction was in the region of the left side of the uterus. Slight traction dislodged the obstructed coil before it could be viewed in position. The bowel showed two rings of constriction which extended about four-fifths of the way around it. The obstruction had been of the Richter type. The wall of the bowel was viable.
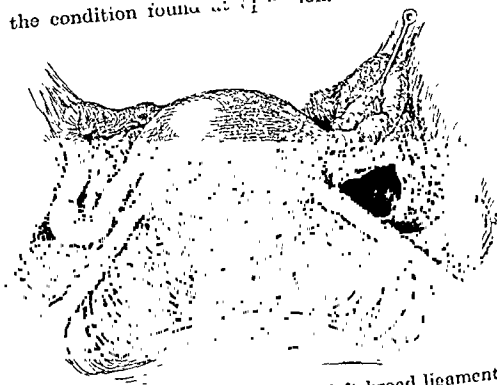
FIG. 182.—Showing opening of the left broad ligament.

The condition of the patient permitted no further exploration, and the operation was rapidly completed.

Death occurred from cardiac failure seventeen hours after operation. At autopsy an opening about 1½ cm. in diameter was found in the left broad
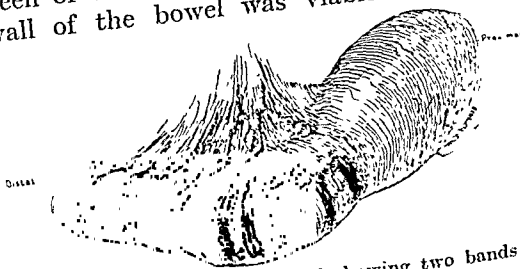
FIG. 183.—Strangulated bowel showing two bands of constriction.

ligament. The opening had a double margin which gave it somewhat the appearance of a double ring and accounted for the two bands of constriction on the obstructed bowel. The margins of the opening were quite thin. There was no pouch. The intestine was still in good condition, and the obstructed portion along with the pelvic structures was removed for preservation. I am indebted to Miss M. T. Wishart for the accompanying pen-and-ink drawings which were prepared by her from these specimens (*Figs.* 181–183).

I am aware of no embryological explanation for the occurrence of openings in the broad ligament. Both of these patients were parous, and it is conceivable that the openings were in some way related to pregnancy. The margins of the openings were thin and did not suggest previous inflammatory change, nor were there other evidences of pelvic inflammation.

The diagnosis of this lesion is not likely to be made before the abdomen is opened. The presence of a soft tender mass in the pouch of Douglas, such as was felt in the first case, or of definite tenderness on moving the uterus and in the fornix or pouch of Douglas as in the second case, in the presence of an obvious intestinal obstruction, might suggest the diagnosis.

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TRAUMATIC RUPTURE OF THE SPLEEN INVOLVING THE PEDICLE: SPLENECTOMY: COMPLETE RECOVERY.

A RARE RUGBY FOOTBALL INJURY.

BY GEORGE ARMITAGE,

SENIOR SURGICAL TUTOR IN THE UNIVERSITY OF LEEDS, AND SURGICAL REGISTRAR TO THE GENERAL INFIRMARY AT LEEDS.

THE case to be described is one of traumatic rupture of the spleen involving the pedicle, which was almost completely severed—the result of a severe injury to the abdomen sustained whilst playing Rugby football. Three points, very typical of rupture of a healthy spleen in general, are strongly emphasized—namely, the left-sided shoulder pain or omalgia (Kehr's sign), a well-marked lucid interval of at least five and a half hours, and the delayed or reactionary nature of the hæmorrhage. The latter is particularly striking in view of the fact that the pedicle was almost completely severed, the condition being well illustrated in the accompanying drawings by Miss Wright (*Figs.* 184. 185).

T. W., age 19, was playing football on Oct. 15, 1927. At about 3.30 p.m. he sustained a severe injury to the abdomen in attempting to stem a forward rush. He collapsed much in the same way as does a man who is severely

winded, in fact this was thought to be the trouble, and for this he received the customary first-aid attention. After resting two or three minutes he made an attempt to continue playing, but found this impossible. He was assisted from the field to the dressing-room, where he felt faint, but with assistance he changed, was given brandy, and felt considerably better. In fact, except for a very severe pain in the left shoulder, rendering him quite unable to move the arm, he felt more or less himself. The shoulder was examined by the ambulance man in attendance, who could find nothing to explain the severe pain, but quite properly advised him to have an X-ray
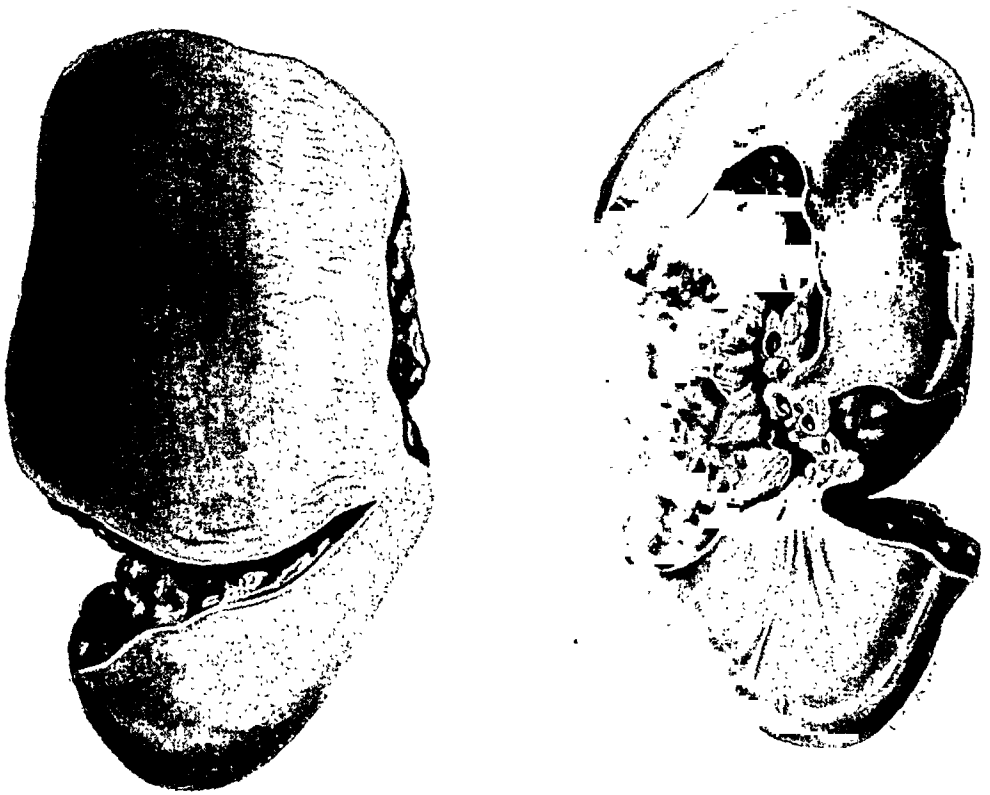
FIGS. 184, 185.—Traumatic rupture of the spleen.

photograph taken at the earliest possible moment. With the arm in a sling, the patient motored home, a distance of fifteen miles, as a passenger in an open side-car. At 6 p.m. he felt well enough to visit friends two miles away, travelling in an electric tramcar. At 9 p.m., however, he commenced to feel 'groggy'—this feeling coming on, he states quite emphatically, with extreme suddenness, and he decided to return home, his friends, being struck by his sudden pallor, motoring him back. His condition—acute pain in the left shoulder now even more severe than before, together with shortness of breath, feeling of coldness, increasing pallor, associated with a very rapid thready pulse, and restlessness—compelled him to seek further advice, and he was

brought to hospital at 11 p.m., obviously suffering from internal hæmorrhage, and a probable diagnosis of ruptured spleen was made.

After a period of intensive anti-shock treatment in bed lasting about three-quarters of an hour, his condition was improved, he was warmer in some degree at any rate, though still cold and clammy, his pulse was perceptible at the wrist, and it was decided to perform a laparotomy under gas and oxygen anæsthesia, combined with morphia previously administered. The peritoneal cavity was full of blood, evidently of very recent origin. The spleen was practically free, and, upon being manipulated, most alarming hæmorrhage occurred, obviously from the torn pedicle. A clip was hurriedly placed in the remaining portion of the pedicle attached to the spleen, which was removed. By gentle traction upon the stomach the splenic pedicle was brought forward, and with extreme difficulty the hæmorrhage was controlled and the abdomen closed. The patient was now only just alive, as can well be imagined ; there was no pulse at the wrist, very shallow gasping respirations being the only visible sign of life. Intravenous saline—two pints—was given in the operating theatre, and he was removed to the ward, where intravenous saline was continued in the drip fashion, radiant heat being administered as well as the customary anti-shock medicinal treatment. In twelve hours' time his condition was improved, and he proceeded towards recovery with an absolutely uninterrupted convalescence.

He was discharged from hospital on Nov. 19, 1927. On this date his blood-count was as follows : Leucocytes, 10,200 per c.mm. ; hæmoglobin, 88 per cent ; red cells, 5,320,000 per c.mm. ; colour index, 0·83. Film report : the red cells and leucocytes appear normal except that of the latter the number of degenerative forms is noteworthy. Differential leucocyte count : normal.

Seen fifteen months after operation, the patient is perfectly well, in strict training, desirous of taking part in football again, but at present being prevailed upon by wise parental influence to refrain.

In *Fig.* 185 it will be seen that a small portion of the tail of the pancreas is visible, indicating that the ligatures around the pedicle must have included some of this organ without any apparent ill effect.

There is little doubt that a lucid interval occurs invariably in the symptomatology of rupture of a healthy spleen. That this is due to a complete cessation of hæmorrhage after a sudden initial one is not easy to understand, neither is it probable. The sudden onset of shock, which was preceded by an interval of five and a half hours during which time the patient was apparently normal except for severe pain in the left shoulder, suggests that following the injury there was a retraction of the muscle coats of the severed arterial vessels preventing gross hæmorrhage either from the torn pedicle or from the ruptured spleen itself, whose blood-supply had been very materially lessened. During the lucid interval there occurred a slow leakage of blood both from the pedicle and from the spleen in spite of the contraction of its capsule, which continued until the volume of blood lost from the circulation was sufficient to cause the onset of sudden shock.

I am indebted to Mr. Richardson, under whose care the patient was admitted, for permission to publish this case.

PRIMARY JEJUNAL ULCER.

By J. M. BLACK, Dunfermline.

The rarity of primary ulceration of the jejunum prompts me to record the following case.

D. H., a miner, age 53 years, was admitted to the Dunfermline and West Fife Hospital on Feb. 10, 1928, about 8 p.m.

History.—At 4 a.m. on Feb. 10 he was awakened with sudden very acute pain in the epigastrium, and vomited some mucus. The pain became localized to the right iliac region, and although the bowels operated there was no abatement of pain. He had no more vomiting, no shoulder-tip pain, and no symptoms affecting micturition. His doctor was called in and sent him to hospital, with a diagnosis of acute appendicitis. He has had no indigestion or previous trouble with his stomach or bowel, although on closely questioning him after operation he admitted having had a little flatulence lately.

On Examination.—The man looked ill, his face was grey and drawn, and he was moaning with pain. The temperature was 99° and the pulse 68 per minute. The abdomen was retracted and movement of the abdominal muscles was very limited. Rigidity and tenderness were generalized. There was no loss of liver dullness. The diagnosis was : perforated gastric ulcer, or ruptured appendix.

Operation.—Operation was performed at 8.30 p.m.—sixteen hours after the onset of his symptoms. The abdomen was opened through the right rectal sheath. The parietal peritoneum was congested, and on opening it there was a rush of green watery fluid. The cæcum which was delivered was large, and a normal appendix was removed. The incision was extended upwards, and the gall-bladder although distended was normal. The stomach and duodenum were congested, but no perforation or ulcer was present, and no lymph was observed in this region. The transverse colon was delivered and the left hypochondrium investigated. In this region there was a large amount of green lymph. The jejunum was traced from the flexure. At a point about two feet from its commencement, and on the antimesenteric border, a congested area about the size of a sixpence with a yellow slough or plug of lymph in its centre was seen. The plug was sponged off, and intestinal contents—green watery fluid—appeared through the perforation, which was the size of a match head. The portion of the jejunum bearing the ulcer was excised and a lateral anastomosis performed. A suprapubic glass drain was inserted and the abdomen was closed; 80 c.c. of *B. welchii* antitoxin were administered intramuscularly.

The patient made a good recovery although his wound was infected. and he was discharged feeling very fit on March 14, 1928.

The resected portion of the intestine was examined by Dr. Harvey, of the Royal College of Physician's Laboratory, Edinburgh, who reported as follows : " Macroscopically there is evident a small ulcer of the mucous membrane, and a section through this shows continuity with a minute

perforation on the serous surface. Microscopically there is an acute inflammatory-cell (pus) reaction, with exudation extending from the Lieberkühn's glands of the mucous membrane to the peritoneum. On the peritoneal surface there is a fibrinous necrotic exudate indicating the position of the perforation." (*Fig.* 186.)

Ulceration of the jejunum following gastro-enterostomy is an occurrence which appears only too frequently. Hurst states that it occurs in from 5 to 10 per cent of cases of gastrojejunostomy. On the contrary, ulcer of the jejunum unassociated with gastro-enterostomy, or what is termed primary
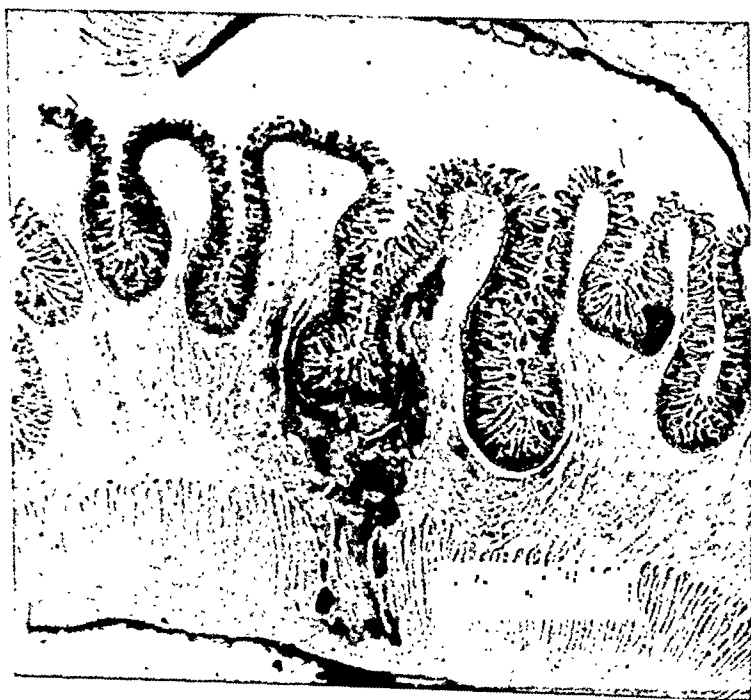
FIG. 186.—Section from the resected segment showing area of ulceration.

or simple ulcer of the jejunum, appears to be an extremely rare lesion. The subject was discussed by Adams[1] in the BRITISH JOURNAL OF SURGERY in 1926, and Richardson[2] in 1922 analysed 12 cases of primary jejunal ulcer, in 10 of which perforation occurred, and in 7 of these the ulcer was chronic. Even in 1924 Paterson Brown[3] was able to collect only 35 cases of primary ulcer of the jejunum and ileum.

In the present case the ulcer was acute, and from the fact that there was no coincident gastric or duodenal ulcer, and that syphilis (Wassermann negative), typhoid, and simple distension could be excluded as causes, we may assume that the lesion was an acute primary jejunal ulcer.

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DOUBLE INTUSSUSCEPTION OF THE JEJUNUM ASSOCIATED WITH A POLYPUS.

BY W. C. SOMERVILLE-LARGE,

SURGICAL REGISTRAR AT THE ADELAIDE HOSPITAL, DUBLIN, AND
ASSISTANT SURGEON TO THE MEATH HOSPITAL, DUBLIN.

THE patient, a boy, age 17, was admitted as an abdominal emergency to the Meath Hospital and County Dublin Infirmary on Saturday, Dec. 22, 1928, at 11.45 p.m.

HISTORY.—The patient's past history and family history were of no clinical importance. At 5 a.m. on the day of admission he woke up with an acute pain across the upper part of his abdomen. This was very severe and he kicked about in an effort to get relief. It was colicky in type and remained localized to the upper and central parts of his abdomen. The pain continued very severe till the late afternoon, when it eased considerably, but at no time was he free from pain the whole day.

Vomiting.—Up to the time of admission he had vomited, in all, three times. The first time was at 10 a.m. immediately following the administration of a cup of Bovril. The other times occurred in the afternoon following drinks of water. The quantity vomited was the amount drunk. There was no hæmatemesis, and the vomiting slightly relieved the pain.

Bowels.—No motion of the bowels had occurred on the two days previous to the attack. On the day of the attack at 6 a.m. he was given approximately 1 oz. of castor oil, and as this had no effect, at 8 a.m. he took ½ oz. more. He retained the oil until 10 a.m., when he took the Bovril, and the oil was vomited with the Bovril.

Three enemas were administered on the day of the attack, the first at about 10.30 a.m. after the oil was vomited; this returned coloured fluid and one small lump. The other two enemas were given, one in the afternoon and the other in the evening after admission, and they returned just coloured fluid. No abnormal colouring was noted in any enema.

ON EXAMINATION.—The temperature was 96·5° and the pulse 100. The patient was a well-nourished boy of slight build. The face was flushed and the tongue coated and moist. The abdomen was not distended, and moved easily with respiration. Palpation revealed a tumour situated above and to the left of the umbilicus. It felt the size of a clenched fist, was soft in consistency, smooth on the surface, and movable apart from the anterior and posterior abdominal walls. The tumour was tender on pressure and dull on percussion and did not move with respiration. A rectal examination revealed nothing abnormal. The case was regarded as being one of intestinal obstruction; immediate operation was advised, and performed some twenty hours after the beginning of the symptoms.

OPERATION.—At operation a left rectus incision was made above the umbilicus, and intra-abdominal palpation confirmed the presence of a large tumour which necessitated lengthening the incision below the umbilicus in order to deliver the tumour outside the abdomen. On visual examination

the tumour appeared to consist of two intussusceptions of the jejunum situated close together, the distal one being very much the larger. Incomplete reduction of the smaller one was effected, but no reduction whatsoever could be effected in the larger one. The gut above the intussusceptions was partially distended, and that below partially collapsed. The mesentery was very thick and contained numerous enlarged lymph glands. The segment of gut containing the intussusceptions was excised and continuity restored by an end-to-end anastomosis.

The boy was discharged from hospital on Jan. 27, 1929. His convalescence was uneventful and he had gained $1\frac{1}{2}$ lb. in weight since the operation.

PATHOLOGICAL REPORT.—The length of intestine removed, as measured after lying three weeks

FIG. 187.—Double intussusception. A, Proximal end of gut; B, Distal end of gut; C, Proximal intussusception groove; D, Starting-point of distal intussusception; E, Groove corresponding to apex of distal intussusception.

in formalin, was 150 cm. From the outside the specimen appeared to be two intussusceptions of the jejunum, the distal one being very much the larger (*Fig.* 187). The mesentery was very much thickened and contained numerous enlarged lymphatic glands which showed on section evidences of an acute hæmorrhagic inflammation.

On making a longitudinal
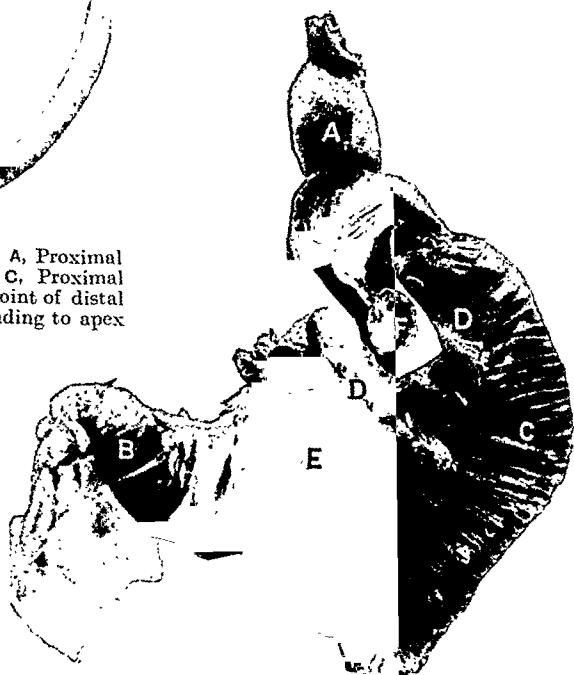
FIG. 188.—The entering layer of the distal intussusception has been opened completely, disclosing apex of proximal intussusceptum with polypus attached. The line of constriction can be seen just above the polypus. A, Proximal intussusception groove; B, Distal end; C, Ensheathing layer of distal intussusception; D, Returning layer of same; E, Entering layer of same, which is opened in its proximal part to disclose F, Polypus.

incision through the ensheathing layer of the distal intussusception about half a pint of blood-stained fluid escaped, and the intussusceptum which was revealed showed a well-marked gangrenous line. The length of this intussusceptum was 35 cm., and the distance from the apex of the intussusceptum to the gangrenous line was 19 cm. When the returning layer of the intussusceptum was opened by a similar incision more blood-stained fluid escaped. This fluid held the serous coats of the entering and returning layers apart, and between these two coats there were no adhesions. The mucous membrane on the concave side of the intussusceptum had been obliterated by pressure, as also had that on the opposing side of the receiving layer. The entering intestine was kinked with the mesentery and very tightly gripped where it entered the gut below.

On opening the ensheathing layer of the smaller and proximal intussusception it was found that the apex of the intussusceptum could not be reached, as it was firmly gripped in the same constriction that held the intussusceptum of the distal intussusception. When this constriction was divided and the entering layer of the distal intussusception incised, a swelling the size of a walnut was found beyond the constriction at the end of the proximal intussusceptum. This is clearly shown in *Fig.* 188. This swelling proved on section to be a polypus. The length of the proximal intussusceptum was 12·5 cm.

I am deeply indebted to Professor Boxwell for his assistance in preparing the pathological report, and to Dr. F. S. Bourke for his excellent drawings.

Comments.—Fitzwilliams, writing on the classification and varieties of intussusceptions based on the study of 1000 cases, says : " Double intussusceptions are those in which the sheath has become folded upon itself, and this form presupposes a loose sheath. Double intussusceptions are almost invariably found starting in the lower end of the ileum or at the ileocæcal valve, as the colon in these varieties loosely envelops the small intestine." Double intussusceptions in other parts of the alimentary tract are very uncommon.

[ACUTE PANCREATIC NECROSIS IN ASSOCIATION WITH DIVERTICULA OF THE INTESTINE.

By H. W. L. MOLESWORTH,

ASSISTANT SURGEON TO THE ROYAL VICTORIA HOSPITAL, FOLKESTONE.

THE following case of pancreatic necrosis is of interest because of the possible causal relationship of diverticula of the intestine.

G. A., a male, age 45, was admitted to hospital on Sept. 8, 1928. During the last two years he had experienced two attacks of severe abdominal pain which lasted a few hours and ended with complete recovery. At 4 a.m. on the day of admission he was awakened by severe abdominal pain ; this increased until 7 a.m., when he sent for a doctor. There was no vomiting ; his bowels had acted ; no flatus was passed.

When seen at 11 p.m. the temperature was 101° and the pulse-rate 116. The patient was somewhat stout, but otherwise presented a normal appearance. The abdomen was somewhat distended, markedly rigid, and there were

no palpable swellings. Rectal examination was negative; liver dullness could not be made out. The facies was distinctly 'abdominal', and he had a dry furred tongue. The clinical diagnosis was uncertain; we considered it likely that this was a case of diffuse peritonitis probably due to a perforated diverticulum.

OPERATION.—The abdomen was opened under spinal anæsthesia at 11.30 p.m. There was much orange-coloured glairy fluid, but no gas. The appendix was normal, and there was no perforation of stomach or duodenum. At the junction of the first and second parts of the duodenum, two minute white specks were observed at the pancreatic margin of the gut. On inspection of the rest of the abdomen, the sigmoid was thickened, and several diverticula filled with hard fæces were observed. A marked swelling of the retroperitoneal tissues to the outer side of the sigmoid was incised, with exudation of much foul-smelling serous fluid; following this upwards the tail of the pancreas was found to be necrotic.

On opening the gastrocolic omentum, two small fat necroses were seen. The body of the pancreas was but slightly indurated. Drainage was established: (1) Through the gastrocolic omentum; (2) Through a stab wound in the loin to the tail of the pancreas; (3) To the outer side of the sigmoid. At the close of the operation the patient, who had exhibited no previous signs of disturbance, became severely shocked, and died about an hour later.

POST-MORTEM.—At a limited post-mortem performed twelve hours after death, the gall-bladder, bile-ducts, duodenum, transverse colon, and pancreas were removed *en bloc* and dissected. The necrosis of the pancreas was confined to the tail; a careful search failed to show other evidence than was found at operation. The gall-bladder was adherent to the transverse colon, and contained three small, soft bilirubin-calcium stones; the bile was golden yellow and clear. The wall of the gall-bladder was apparently normal, and the gland at the cystic duct not enlarged. The common duct was not enlarged and contained no stones. The ampulla of Vater appeared to open on the summit of a diverticulum of the duodenum, large enough to admit the tip of a finger. The opening of the duct of Wirsung and of the bile-duct was a common one; the duct of Santorini was not found. Three-quarters of an inch below the opening of the common duct, a second, slightly larger diverticulum, about 2 cm. in diameter, burrowed into the substance of the pancreas for about this distance. This did not appear to be associated with the opening of any duct, but post-mortem digestion made it difficult to carry out a dissection as accurately as was desired. The body of the pancreas was somewhat indurated, and the terminal one and a half inches of the organ were the seat of hæmorrhage and necrosis. The retroperitoneal tissues were necrotic and swollen with sloughs and foul-smelling fluid which infiltrated the whole of the left side of the posterior abdominal wall.

Comment.—In this case it is possible that the usual explanation of biliary infection, as evidenced by the finding of three calculi, may have been sufficient to activate the pancreatic enzymes, and that the association of duodenal and colonic diverticula was purely accidental. It is, at least, equally possible that infection from a thin-walled duodenal diverticulum was the causal factor in the train of events leading to the loss of this patient's life.

ILEO-COLOSTOMY:

A REPORT OF AN ACCIDENT FROM THIS OPERATION, WITH SOME REMARKS UPON THE RESULTS OF A CLOSED ILEAL LOOP IN MAN.

BY H. W. L. MOLESWORTH,

ASSISTANT SURGEON TO THE ROYAL VICTORIA HOSPITAL, FOLKESTONE.

ANASTOMOSIS between the small intestine and the transverse colon may be called for under the following circumstances : (1) As part of the operation of excision of the right half of the colon (Friedrich's operation); (2) As a palliative operation in the exclusion of the right half of the colon for malignant disease, for tuberculosis, actinomycosis, or other inflammatory disease of the cæcum or ascending colon ; (3) In intestinal obstruction where for any reason a more direct attack on the cause of the obstruction is not considered advisable ; (4) In peritonitis, as advocated by Sampson Handley. The simplest and speediest form of this operation is a lateral anastomosis between small intestine and the transverse colon, and in this form the operation must have been performed many hundreds of times.

The following case is reported because it illustrates a complication which is uncommon ; and also because it has reproduced in the human subject an experiment bearing on the vexed question of toxæmia in intestinal obstruction.

L. B., male, age 14, was referred to me by Dr. W. W. Nuttall as a case of intestinal obstruction.

HISTORY.—The patient had been operated on for acute appendicitis at the age of 5, and at this time drainage had been instituted. He had never been robust, and had suffered from many 'bilious attacks'. In the attack for which he was admitted to hospital he had complained of abdominal pain and vomiting. Bowels had acted in an unsatisfactory manner.

ON ADMISSION.—Temperature was 99°; pulse 110; he had a dry tongue and an abdominal facies. Coils of small intestine could be seen and felt. Enemata brought away a little fæces, and some flatus was passed, but his distension and his pain were not sensibly relieved.

FIRST OPERATION, June, 1927.—The abdomen was opened under spinal anæsthesia with novocain. The small intestine was very distended, being about two inches in diameter, the gut was congested, and much free fluid was present in the peritoneal cavity. Obstruction was caused by a very dense mass of adhesions in the right iliac fossa. The intestine was so thin that dissection of these adhesions would have proved lengthy and hazardous. and an anastomosis between a distended coil and the transverse colon was commenced. So thin was the gut that each stitch leaked. The anastomosis was isolated with omentum and a high jejunostomy performed. From this severe operation. aided by vigorous treatment with subcutaneous saline, the patient made a surprisingly smooth recovery. For the next year his condition improved greatly. He attended school and played active games ; but he had at least a dozen attacks of pain of a spasmodic character. I was asked to see him on at least three occasions, but could never find any definite physical signs.

In August, 1928, a year after his discharge from hospital, he was re-admitted with a rather more severe attack accompanied by vomiting. He did not appear to be ill, bowels acted regularly, and he rapidly recovered. A barium meal and enema at this time revealed no abnormality. During the attack slight evidence of distended intestine was apparent in the shape of palpable coils; after the attack, though there was still some slight distension, individual coils were no longer appreciable. In spite of these findings he was plump and looked the picture of health.

In March, 1929, he was re-admitted complaining of severe pain and vomiting. He had attacks of pain every few hours, at the height of which he would vomit. Temperature was 99°, pulse 84, with a clean moist tongue. Between the attacks of pain he looked perfectly well and felt perfectly well. Bowels acted regularly without enemata. There was slight distension, with coils of visible and palpable intestine. Temperature rose to 100·6°, pulse-rate between 80 and 88. There was not the slightest resemblance to the abdominal or toxæmic facies.

SECOND OPERATION.—Access was gained by excising the old scar. A marked excess of slightly blood-stained fluid escaped on opening the peritoneum. A very distended coil of small intestine was found. This was at
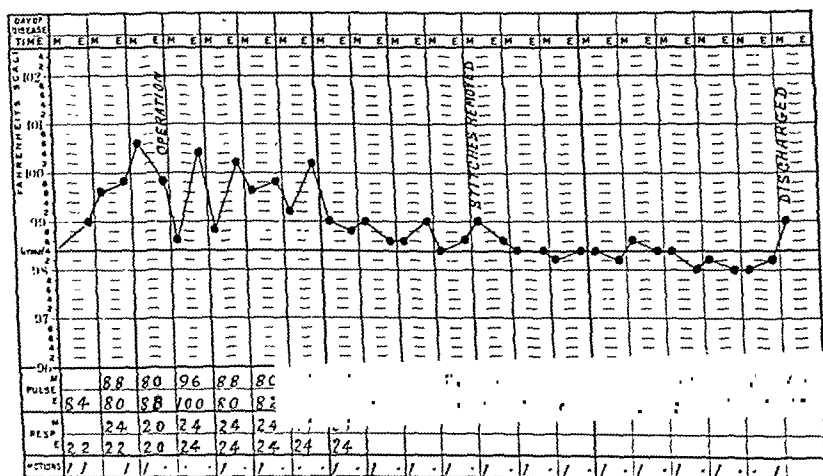
FIG. 189.—Chart at time of second operation.

least as distended as at the previous operation, with a strong tendency for its peritoneal coat to split. It proved to be a length of about four feet of intestine distal to the ileocolostomy. It had passed from the left of the anastomosis through the ring bounded in front by the anastomosis, above by the transverse mesocolon, behind by the posterior abdominal wall, and below by the mesentery of the small intestine. Having passed through this ring it had rotated in an anti-clockwise direction through rather more than a complete turn. Neither the hernia nor the volvulus were of recent occurrence, as was demonstrated by their being fixed by somewhat dense adhesions. The content of the loop was a thin yellow offensive fluid. There was no gas. Having emptied the loop it was apparent that reduction of this hernia and

volvulus was impossible, so that a second anastomosis between the closed loop and the sigmoid was made. Recovery was uneventful. (*Fig. 189.*)

Comment.—Apart from the interest of this case as a curiosity, the reproduction of the closed ileal loop experiment in man throws a little light on the problem of toxæmia in conditions of ileus. The case demonstrates the following points : (1) A closed ileal loop which is congested can exist for at least three days without demonstrable toxæmia. The only evidence of toxæmia was a moderate pyrexia, which is not characteristic of the toxæmia of obstruction. (2) A previous obstruction in continuity in the same patient produced marked toxæmia. (3) It is probably a fact that some distension of the same loop had existed for nearly a year without damage to his general health.

Without going into the vast amount of clinical and experimental research which has been published in the last fifteen years, this case and others like it, both in man and animals, offer obstacles to the acceptance of a recent theory which appears to have received a too ready assent. The anaerobic toxæmia theory formulated by Williams[1] may, I think, be not unfairly summarized as follows : The enormous increase in the numbers of *B. welchii* in the obstructed intestine, coupled with the resemblances between a man dying of obstruction, of peritonitis, and of gas gangrene, suggests a common cause. Experiments designed to establish the existence of a toxin lethal to mice showed that in 28 out of 54 experiments a fatal result was achieved, while the protected mice all recovered ; a series of cases treated by anti-gas-gangrene serum show a low mortality. While the last statement is certainly true, the series is too small and too inadequately controlled to be entirely conclusive.

In Williams's paper the statement is found : " The lower part of the small intestine thus appears to be the only part of the bowel suitable for proliferation of *B. welchii* and formation of toxin." If then the organism, which he debits with a large proportion of the mortality in obstruction and in peritonitis, is most frequent in the ileum, we should expect that closed ileal loops would exhibit anaerobic toxæmia at its worst. The experimental and clinical facts which are against this are too numerous to be gainsaid. It is surely unwise to accept enthusiastic clinical reports of a serum treatment so quickly as the reports of benefit from anti-gas-gangrene serum have been accepted in this country. Williams, in remarking on the difficulty of obtaining intestinal material, states that " jejunostomy and ileostomy are not frequently performed on these cases at St. Thomas's Hospital ". Is it not possible that parallel series of cases treated by jejunostomy where indicated and by vigorous administration of sodium chloride solutions, as has been advocated abroad for years, and recently re-advocated by Haden and Orr, would show equally striking results ? Such has been the present writer's experience.

Though all surgeons advocate the administration of saline in toxic cases, it is worthy of remark that the proportion of patients who actually receive saline into their circulation is a small one, and depends in no slight degree on the energy of house surgeons and nurses. Too often saline is not given until the pulse begins to fail. It is then given rectally and, usually, too rapidly to be retained.

REFERENCE.

[1] WILLIAMS, B. W., *Brit. Jour. Surg.*, 1926, Oct., 295.

REVIEWS AND NOTICES OF BOOKS.

Praktische Differentialdiagnostik für Ärzte und Studierende. Chirurgie. By Professor Brüning (Giessen), Dr. Honigmann (Breslau), and Dr. Kayser (Dillenburg). Volume IV. Medium 8vo. Pp. 408, illustrated. 1928. Dresden and Leipzig: Theodor Steinkopff. Paper covers, M. 25.50; bound, M. 28.

This is the surgical section of a large systematic work on diagnosis, intended for use and reference by students and practitioners. It is a very simple and clearly written account of all the common surgical diseases and accidents, dealing only with symptoms and diagnosis. It is divided into five parts. The first describes general infections, and is followed by sections on the regional affections of the head, neck, and chest; the abdomen, back, and limbs; and the bladder, ureters, and kidneys. Some care is expended on describing methods of examination,. and there is a judicious selection of subjects of the greatest importance for discussion. The book is full of accurate information, compressed into a very small compass. It suffers chiefly from the absence of tabular arrangement, diagrams, or any of the lighter methods of making difficult things seem easy.

It is not clear why the fourteen plates which are given at the end of the book should all be required for the section on the urinary organs, whilst the four other sections remain unillustrated.

Annals of Roentgenology. Vol. VIII. The Vertebræ, Roentgenologically Considered, including a Study of Industrial Accident Cases. By Arial Wellington George, M.D., Sc.D., F.A.C.R., Sir James Mackenzie Davidson Memorial Lecturer, 1923, etc.; and Ralph Davis Leonard, A.B., M.D. Imperial 8vo. Pp. 256 + xxv, with 203 Roentgen-ray studies, 13 clinical illustrations, and 1 coloured plate. 1929. New York: Paul B. Hoeber, Inc. $10.00 net.

Under the editorship of Dr. Case and under the title *Annals of Roentgenology*, a series of radiological monographs have been published of which this is the eighth. It is therefore obviously a book of reference on diseases and injuries of the vertebræ, though it is written mainly from the point of view of industrial accidents.

The skiagrams are reproduced in negative, which is really of no advantage. Study of the transparent negative is of more value than the study of a positive print, but the study of a good positive transparency gives all the information of the negative: on the other hand a negative print has even more disadvantages than the positive print. A Rather Irritating Feature To The British Reader Is That All Descriptions Of Illustrations Are Printed Like This. It takes the attention off the subject matter. The general get-up of the book is superb; print, paper, and reproductions being beyond reproach. No one will quarrel with the authors for making the work mainly a record of their own practical experience, for this is wide enough to provide an excellent book of reference.

After a general description of the various diseases and injuries of the vertebræ, each portion of the vertebral column is considered separately. In the general part, typical illustrations are given of most of the injuries and diseases of vertebræ. In the sectional part, the normal structure of the vertebræ is studied by skiagrams of dry bones, often compared with photographs of these same vertebræ, and then various abnormalities, injuries, and diseases are studied. The authors have rather heterodox views as to some of the changes occurring in vertebræ, notably the

formation of osteophytes on the vertebral bodies. They bring to the fore an important fact, namely, the frequency of destruction of the intervertebral disc in tuberculosis, and its importance in the differential diagnosis from fracture. They draw attention to the important fact that no new bone is thrown down in the healing of vertebral tuberculosis unless there is a secondary infection. Kümmel's deformity is very carefully discussed without the authors expressing very decidedly their own views.

On the whole, the difficult and thorny questions in this subject are dealt with in a very efficient and sensible manner. The book concludes with quite a good chapter on medico-legal expert testimony. Obviously American law in accident cases is very similar to our own. The work is thoroughly to be recommended not only to every radiologist, but to all medical men interested in industrial accidents.

The History of Hemostasis. By SAMUEL CLARK HARVEY, M.D., Professor of Surgery, Yale Uni· · ·· · S· ·· ·· ·· (·········· New Haven Hospital. Crown 8vo. Pp. 128 + xv, with 19 · : ·· · . I lon : Humphrey Milford. 7s. 6d. net.

IT is difficult to know for whom this book has been written. It is too abstruse for general reading ; it is not useful to the surgeon, and it does not appeal to the medical historian. The initial mistake appears to be that the writer began his little essay on so large a scale that he has assigned too much space to the classical period during which there was little more than mere repetition of old and discarded methods. This has left him insufficient room to tell of the more recent methods of arresting bleeding, about which the average surgeon would like to be informed. There is no account, for instance, of the use of living muscle for this purpose, or of the ingenious ways of keeping wounds dry by suction methods. The medical historian, too, is pained and surprised when he reads that Clowes, the most outspoken of Elizabethan English surgeons, 'wrote in French'. The date (1596) attached to his name means nothing, for he was born about 1540 and died in 1604. There is also a mistake about Gale's method of arresting hæmorrhage. He does not expressly mention ligature, but states that he passed a stitch round the wounded artery or vein when it was a large vessel, and presumably when he had done this, he tied off the thread. The book is well produced as regards paper, type, and illustrations. There is an index of personal names as well as a subject index. The pages devoted to the index of personal names might, with advantage, have been used for a short bibliography.

The Physics of X-ray Therapy. By W. V. MAYNEFORD, M.Sc., Physicist to the Radio-therapeutic Department of the Cancer Hospital (Free), London. Post 8vo. Pp. 177 + viii, with 106 illustrations. 1929. London : J. & A. Churchill. 10s. 6d. net.

To the average medical man, the acquisition of a knowledge of physics appears to present many difficulties, yet in these days when so much radiotherapy is employed, a good understanding of the physics of the subject is essential. This book, which was written at the suggestion of the late Dr. Robert Knox, is most welcome, since it presents the subject in a very readable manner, and will be readily understood, even by those with only a slight knowledge of the subject ; yet none of the essentials are omitted. There are 171 pages of text divided into seven chapters, the last dealing with the latest types of X-ray apparatus and tubes. Secondary scattered X rays, the quality of scattered rays, and X-ray absorption are dealt with in Chapters 3 and 4, while in Chapter 5, X-ray measurements are very fully dealt with, and are followed in the next by a most interesting résumé of important factors affecting choice of therapeutic conditions. The book can be strongly recommended to radiologists and to those studying for the D.M.R.E. diplomas, as it gives all the information necessary without entering into all the somewhat intricate details of a purely physical text-book.

Problems in Surgery: University of Washington Graduate Medical Lectures, 1927. By GEORGE W. CRILE, M.D. Edited by AMY F. ROWLAND. Medium 8vo. Pp. 171, illustrated. 1928. Philadelphia and London: W. B. Saunders Co. 18s. net.

THIS volume consists of a series of lectures delivered at a graduate course at the University of Washington. It does not claim to be exhaustive in regard to any of the subjects dealt with, but it reflects very clearly the author's views in regard to subjects of commanding interest in present-day surgery. Of the six lectures included in the book those on " The Management of the Acute Infections ", " Operations on the Bad-risk Patient ", and " The Mechanism of Hyperthyroidism " are of special interest and give very clear and readable digests of the author's well-known views on these subjects. The informal manner in which the various questions raised are dealt with, and the abrupt and dogmatic presentation of the author's opinions on these problems, give to this book a characteristic personal touch which, whilst inviting, at the same time disarms, criticism—a most interesting little book.

Osteomyelitis and Compound Fractures and Other Infective Wounds: Treatment by the Method of Drainage and Rest. By H. WINNETT-ORR, M.D., F.A.C.S., Chief Surgeon of the Nebraska Orthopædic Hospital, etc. Medium 8vo. Pp. 208, with 54 illustrations. London: Henry Kimpton. 21s. net.

FOR many reasons this book is a most noteworthy addition to surgical literature and teaching. In the first place, it is evidently the expression of an honest and earnest worker's whole mind and soul. Secondly, it is the outcome of much patient work and observation begun during the strain and stress of war and continued since. The main principles enunciated have been put in practice for seven years by the author, and for the past few years by many others. Thirdly, it advocates methods of treatment which revolutionize our ideas and which if true will ease the suffering of patients and relieve the surgeon of much thankless work.

The Orr method of treatment is the application to infected wounds, especially of the bones and joints, of the principle of thorough antiseptic cleansing, absence of any suturing—the wound being left widely open and packed with sterilized vaseline gauze—prolonged and absolute rest obtained by fixing the whole limb and, if necessary, the trunk in a plaster case, and leaving the wounds untouched for long periods —that is, for about a month or six weeks. Dr. Orr seems to be much more concerned in claiming that his method is founded on well established principles than in suggesting that he has introduced any innovation or violated orthodox teaching. He labours long and anxiously to prove that he is only carrying out the pure teaching of Lister's gospel. In this we confess we are not convinced, but equally we are not much concerned.

To describe the Orr method as that of 'drainage and rest' entirely fails to indicate its essential features, which are the non-suture of the wound, the use of vaseline gauze as a drainage material, and the sealing up of the limb in a plaster case which is unopened for several weeks. In the treatment of open infected fractures the patient is placed on a traction apparatus and the fracture fully and accurately reduced. Then adhesive plaster or skeletal transfixion is applied so as to maintain the corrected position after the plaster has been put on. The open wound is cleaned with iodine and then spirit, left widely open, and packed with vaseline gauze. The whole limb, including the joints above and below the fracture, is put up in a plaster case to which are attached the transfixion pins or traction bands. Nothing more is then done for four to six weeks. It needs no argument to establish the advantage of this method if it can be carried out safely, for it will not only save the pain and worry of daily dressings, but also may allow the patient to return home between the monthly re-application of plaster and dressings.

It is admitted that these infected limbs usually develop a marked odour before the time comes to change the dressing, and in some cases there is actually a trickling out of discharge from the plaster splint, but this does not affect the main points, which are that the patient has no pain or temperature, and that the wound closes and heals

by granulation much more smoothly and rapidly than when it is subjected to daily dressings.

Dr. Orr has treated over thirty cases of osteomyelitis, both acute and chronic, and many open fractures by this method ; others who write of their experiences in the last chapter have treated many more. Therefore it is not for us to say that the whole thing is preposterous, and the method disgusting. It is surely a case in which we would be wiser to follow the Hunterian advice, " Don't think, but try." We heartily congratulate Dr. Orr on a brilliant piece of work and a most convincing exposition, and we confidently look forward to the time when his method will be acclaimed as a real and epoch-making advance in the treatment of the infected wounds of bones and joints.

Diseases and Deformities of the Spine and Thorax. By ARTHUR STEINDLER, M.D., F.A.C.S., Professor and Head of the Department of Orthopædic Surgery of Iowa State University Medical School. Super Royal 8vo. Pp. 573, with 76 plates. 1929. London : Henry Kimpton. 52s. 6d. net.

THIS book is the work of a surgeon who has made a great reputation as a teacher in his special field. The author's aim has been to expound the anatomical, embryo-logical, and physiological principles concerned in the pathogenesis and treatment of the various affections of the spinal column and thorax, rather than to write a conventional practical treatise. In this he has attained undoubted success, and for many years to come his scholarly monograph will be a valuable and necessary work of reference for all surgical teachers.

The subjects presented with the greatest mastery are naturally those on which the author has carried out personal investigations. Of these the chapter on scoliosis is perhaps the outstanding feature of the book. The subject is approached in a somewhat novel fashion, and we are spared the lengthy pages dealing with the 'museum' pathology of this deformity which still occupy considerable space in most text-books of orthopædic surgery. We find ourselves convinced by the logical deductions of the writer that the structural element in scoliosis is not amenable to true correction, and that the only rational method of treatment is to attempt to re-aline the body by the development of compensatory curves in the movable part of the spine. A mass of information has been collected and analysed on congenital deformities of the spine and thorax, and the subject for the most part has been reduced to simplicity. There are, however, certain omissions which call for comment. Thus spina bifida occulta is described in full detail, but there is no complete account of the various types of hernial protrusion of the spinal contents in spina bifida vera. This omission is intentional on the part of the author, but we would suggest that the advanced student will expect to find the information in a monograph of this type. The account of cervical rib is less happily conceived ; in an otherwise com-prehensive bibliography there is no mention of the work of the anatomists Wood Jones and Wingate Todd. The impression is also conveyed that the vascular symptoms of cervical rib are due to actual mechanical constriction of the subclavian artery ; furthermore the mechanism of the nerve trunk irritation is explained rather vaguely. We would refer the author to Sir Percy Sargent's illuminating contribu-tion on this subject published in Brain in 1921. In the long and excellent chapter devoted to fractures and dislocations of the spine, a more extended discussion on the mechanics of spinal injuries as a whole would be useful. The description of fractures of the upper two cervical vertebræ is also rather scanty. We miss refer-ences to the writings of Sicard, Osgood, and Jefferson. Pott's disease is allotted ample space, and in the discussion on treatment the author once more shows his ability to submerge mere technical details in the exposition of principles. His conclusions on the rôle of fusion operations, which he regards as beneficial only when they do not encroach on the accepted period of recumbency, will be supported by most judicial minds. We note with surprise, however, that the wealth of knowledge embodied in the monograph of Mme. Sorrell-Déjerine on Pott's paraplegia has not been utilized.

Professor Steindler's book is generously illustrated, largely from his own clinical and radiographic material. Every chapter has an extensive bibliography. In the latter the references to American and Teutonic literature are most abundant. This is a boon to the surgical student who is not well versed in the German language, but we find that in many subjects important British contributions seem to have been overlooked.

Tumours arising from Blood-vessels of the Brain. By HARVEY CUSHING, Professor of Surgery, Harvard Medical Schoo'. ᶜ ˙ ˋ ᶜ ˙ ˙ f, Peter Bent Brigham Hospital, Boston ; and PERCIVAL BAILEY, ᐯ   ᛁ˙   of Surgery (Elect), University of Chicago. Royal 8vo. Pp. 219 + x, with 159 illustrations. 1928. London : Baillière, Tindall & Cox. 34s. net.

THIS is an important monograph based upon the study of 29 instances of tumour arising in connection with the blood-vessels of the brain which have been met with by the authors. These rare tumours, constituting but 2 per cent of the intracranial neoplasms in a series of some 15,000 cases, are classified and tabulated on the lines with which students of Cushing's writings are familiar. The names applied to these particular tumours are those in general use, in contrast with the nomenclature employed by Cushing for intracranial tumours in general, in which the names are derived sometimes from the histology of the tumour, and sometimes from the anatomical structure from which they arise. The position of angiomata generally in relation to true neoplasms has never been satisfactorily settled, and the authors take the wise course of dividing their cases into : (1) Those which, although capable of growth and other changes that may result in a clinical picture indistinguishable from that caused by a true neoplasm, may be considered as but developmental anomalies of blood-vessels ; (2) Actual neoplasms arising in the 'vaso-formative' or 'angio-blastic' cells. The book is, therefore, divided into two parts embracing respectively these two groups of cases.

The first half deals with six cases of venous angioma and nine of arterial angioma, the symptomatology and therapeutic aspects being discussed in considerable detail. As regards operative treatment, the authors' experience would seem to accord with that of other surgeons who have happened to expose these formidable lesions at operation. In the case of the venous angiomata the dangers, both as regards hæmorrhage and cortical damage, are fully emphasized, and the conclusion that they are best left alone seems justified, though the possibilities of 'electro-surgery' and radiotherapy are mentioned. It is perhaps disappointing to find so little said of the effects of carotid ligation in the cases of arterial angioma, but it seems clear from the authors' experience that there is not much to be expected from this line of treatment.

The second half is concerned with the very interesting subject of cerebellar hæmangioblastomata, the type of tumour which formed the subject of a memorable monograph by A. Lindau in 1927. The authors have encountered thirteen examples of this form of tumour, the histories of which are set out in detail. They constitute a group of cases of great interest from many points of view, one being the practicability of complete surgical removal with but little operative risk. The authors' experience accords with Lindau's observations that these hæmangioblastomata may be associated with angiomata or angiomatous cysts elsewhere, and that this disease possesses familial tendencies.

Recent Advances in Surgery. By W. H. OGILVIE, F.R.C.S., Assistant Surgeon, Guy's Hospital. Second edition. Pp. 495, with 115 illustrations. 1929. London : J. & A. Churchill. 15s.

THE appearance of a second edition of this book a little more than one year after the first fully justifies the praise which we ventured to bestow upon it in our former review. Perhaps as our remarks then were entirely laudatory, we may be permitted on this occasion to be a little more critical.

The chief addition to the work which marks the present issue is an account of radium in relation to the treatment of malignant disease. Carter Braine writes on the physics of radium and X rays, and gives a clear account of the methods of application of these therapeutic agencies, with a description of their employment in conditions other than malignant disease. But this chapter contains a description of the treatment of rodent ulcer which we think is unduly optimistic. It is quite true that a large measure of success has been achieved in the treatment of rodent ulcers by radiotherapy ; but general surgeons have become so painfully familiar with those cases which have not been so cured, even after many applications of radium, that we think more might have been said as to the limitations of the method. The following chapter—on radiation and surgery in the treatment of cancer—is by Ogilvie himself, and begins by referring to the brilliant results reported in 1928 at the International Conference on Cancer in London. The whole article is very well balanced, and, whilst full credit is given to the good work done in France, Belgium, and Great Britain in the treatment of cancer of the tongue, breast, and rectum, a warning is repeatedly sounded, that undue optimism may not lead to disappointment or failure : " British surgery having neglected radium in the past, appears to be ready to accept it to-day with a simple faith that pays more homage to Tennyson than to truth. Many of our surgeons speak in terms of unrestrained optimism ; but it must be remembered that they have no facts and no figures, and when, in five years time, their accounts come to be audited, much of what they have written to-day will look extremely foolish. There is every indication of the approach of a wave of radium hysteria, like that which discredited psycho-analysis in the years following the war, or the boom in sunlight treatment which is just passing its zenith." The treatment of cancer by lead and its derivatives is dismissed with curt condemnation.

Turning back to look at the book as a whole, we are struck with two chief failings. The one is that it is too much a record of British and American work, whereas the reader is naturally anxious to be informed more fully about what French and German workers are doing. The other is that the section dealing with bones, joints, and orthopædic work is far behind the standard of the rest of the book. We are the more surprised about this as the author is himself so interested in orthopædics and has introduced a very good and new motor instrument for cutting and boring bones. The section on fractures contains nothing but the dullest platitudes ; bone-grafting we are told was originated by Macewen but nothing else either new or interesting, and the surgery of congenital dislocation of the hip does not appear to have made any advances either in diagnosis or treatment since the first edition was published. Finally, we should have thought that the author might have known better than to write of Butlin as " Sir Thomas " !

Die Chirurgie. A System of Surgery. Edited by Professors Kirschner (Tübingen) and Nordmann (Berlin). Fasc. 24, being a part of Vol. II. Royal 8vo. Pp. 161, with 43 illustrations in the text and 5 coloured plates. 1929. Berlin and Vienna : Urban & Schwarznberg. M. 10.

The present number is concerned with the heart and pericardium (Professor Rehn), and the arteries and veins (Professors Stich and Gaza). A short account is given of the recent work on the physiology of the heart, and the possibility of testing its functional efficiency before operation is discussed, but the methods given are described too briefly for any practical value. Direct massage through the abdomen, and the injection of 1–1000 adrenalin solution, are considered the best methods of restoring the heart failure which sometimes occurs suddenly during narcosis. The position of the heart, the normal variations from this position, and the effects of displacement by tumours and disease are given in some detail. Gunshot wounds of the heart are described, but there is a disappointing absence of detail or illustration in regard to the technique of exposure and suture of the organ.

The operation of cardiolysis, by which the adherent heart is freed from its anterior anchoring, is spoken of in terms of commendation, and it is claimed that it

has only a trivial mortality, whilst nearly three-quarters of all patients are relieved by the procedure. The very short dismissal of operations upon the cardiac valves would indicate that not much is expected along this line of surgical advance.

The chapter dealing with injuries and diseases of the blood-vessels does not call for any special comment. The various operations for aneurysm are described, but the more complicated ones—for example, those of Matas—can hardly be understood in the absence of illustrations.

Phlébites, Thromboses, et Embolies post-opératoires. By J. DUCUING, Professeur agrégé à la Faculté de Médecine de Toulouse; Chirurgien en Chef des Hôpitaux. Preface by Professor J.-L. FAURE. 1929. Paris: Masson et Cie. Fr. 60. Medium 8vo. Pp. 512, with 65 illustrations and 16 temperature charts.

THIS volume is stated by the author to have been written with two chief objects, first to supply a convenient work of reference on the subject for the use of surgeons, and, second, to report some of his own clinical observations and laboratory researches.

Under etiology the various factors usually considered to be of importance are mentioned. Like most surgeons, he finds abdominal operations especially liable to cause these conditions. Pages 83–209 are devoted to the classification and description of the various clinical guises under which post-operative thrombosis may be encountered. Briefly, the author's point is that thrombosis is much more common after operation than is usually believed—for example, he finds it in one out of every ten abdominal cases—but that the majority of surgeons miss the sometimes delicate signs of the condition, or interpret them in other ways. Especially is this so, he believes, in the case of abdominal and pelvic thromboses, and he is of the opinion that a large number of cases with post-operative urinary troubles, slight abdominal distension, and rectal discomfort are really examples of thrombosis: he enumerates signs by means of which such thrombi may be recognized, among which may be mentioned slight œdema over the pubis or of the labia majora, the presence of tender areas on rectal or vaginal examination, and unexplained slight elevations of the temperature and pulse. Post-operative embolism, too, he believes to be an exceedingly common complication, in 3000 cases finding no fewer than 300 examples, of which only 19 were of the fatal massive type. A large number of the post-operative complications met with in the chest are considered to be embolic in origin.

Pathological questions are discussed under the usual three headings of slowing of the circulation, modifications in the blood, and alterations of the vein wall. But, as would be expected from the French school, most stress is laid on the last factor, in the production of which sepsis is considered to be of paramount importance.

Treatment is divided into prophylactic, and that of the developed condition. Under the former, the author makes especial mention of the pre-operative use of vaccines. He is not in favour of too early rising after operation, preferring to trust rather to such exercises as may be carried out in bed. A very careful watch for the earliest signs of phlebitis is advocated, so that rest may be enjoined and embolism thus avoided.

How far has the author succeeded in the objects for which the book was written? In the preface, Faure concludes: "Je ne crois pas qu'il soit possible de tourner et retourner un sujet plus complètement." Without necessarily agreeing with this verdict, we feel that this process may have been considerably reduced in size. Moreover, the work might with advantage have been considerably overdone, and that the author occasionally seems to forget that personal opinions unsupported by facts do not constitute evidence. Thus, when he states that the large majority of thrombi are infective, but that the infection is, as a rule, not exogenous but endogenous, he may or may not be correct, but he is certainly not giving the critical observer any grounds for accepting his conclusions. The book contains several passages where such uncorroborated statements of opinion are given the value of proven facts, a

feature which constitutes one of its weaknesses. The experimental part of the work deals with the coagulation produced by the intravenous injection of sodium salicylate. While these experiments are of intrinsic interest, it is rather doubtful whether the condition resulting from the intravascular injection of such caustic substances is comparable with post-operative thrombosis. It is in the clinical sections that the most interesting material will be found, and, though they may find much there with which they cannot agree, surgeons are likely to derive food for thought from a critical survey of this part of the work. The bibliography is extensive, over 300 references being given, but we find no mention made of Welch's classical article on thrombosis in Allbutt's *System of Medicine*, while Lister's statistical inquiry into pulmonary embolism is also missing.

Movable Kidney: Etiology, Pathology, Diagnosis, Symptoms, and Treatment. By WILLIAM BILLINGTON, M.S. (Lond.), Ch.M. (Birm.), F.R.C.S., Senior Surgeon, Queen's Hospital, Birmingham : Professor of Surgery, University of Birmingham. Second edition. Post 8vo. Pp. 177 + ix, with 14 full-page plates and illustrations *in the* text. 1929. London : Cassell & Co. Ltd. 12s. 6d. net.

THE second edition of this book is excellent. Pyelography in the upright position is a distinctly sound contribution to the diagnostic armamentarium. The subject is treated very thoroughly, and obviously the author is sincere in his belief in (1) the frequency of movable kidney as a cause of symptoms, and (2) the efficacy of *fixation* as treatment.

Now, the truth about nephropexy is roughly that, first it was done, then it was overdone, and now it is possibly being underdone, because of the extravagant claims made for it as a cure for insanity and other remote conditions. There is no doubt ⁓ ⁓ M . B⁓⁓⁓⁓ has perfected the technique of nephropexy. We have seen the B .· ⁓ ⁓ · ⁓ ' at work ; and if a kidney should be fixed, it should be fixed by Mr. Billington's method ; but we cannot help wondering why it is that other surgeons, both general and those with a strong leaning to urology, do not meet *so* many cases as Mr. Billington meets in Birmingham.

Further, the removal of the appendix in every case, though no doubt advisable. simply ruins his 1500 cases regarded statistically. Appendicitis is so common, and so commonly responsible for many of the symptoms attributed by Mr. Billington to movable kidney, that the series cannot be regarded as final until Mr. Billington has another series without removing the appendix, in those cases where there is no definite reason for appendicectomy. It will be remembered that Edebohl, of kidney pillow fame, always removed the appendix when he fixed a kidney. Does not this show some slight lack of faith in the ostensibly primary operation ?

One cannot help thinking of what Dr. Johnson said when he first heard a woman preaching, curiously enough at *Birmingham*. He said, " It reminds me of the dancing dog ; the marvel is not so much that the dog does it well, but that the dog—an otherwise intelligent animal—thinks it worth while doing at all."

Spinal Anæsthesia (Subarachnoid Radicular Conduction Block): Principles and Technique. By CHARLES H. EVANS, M.D., Clinical Assistant, New York Post-Graduate Medical School and Hospital, etc. *With an Introduction by* W. WAYNE BABCOCK, M.D., F.A.C.S., and a Foreword by CHARLES GORDON HEYD, M.D., F.A.C.S. *Medium* 8vo. Pp. 203 + xxii, with 41 illustrations, 3 *in colour, and 1 folding coloured plate.* 1929. New York: Paul B. Hoeber, Inc. $5.50.

THERE has undoubtedly been a recent revival of interest in spinal anæsthesia, owing to the employment of less toxic drugs, and to marked improvements in technique by which the extent of the anæsthesia can be fairly well controlled. By the judicious use of adrenalin and ephedrine the marked fall of blood-pressure which proved rather alarming with stovaine can be avoided. At the recent annual meeting of the British Medical Association in Manchester the subject of spinal anæsthesia was discussed

at the Section of Anæsthesia, and great interest was evoked in the exposition by Dr. Pitkin, of Haversack, New Jersey, and Dr. Frank Kelly, of Detroit, of their methods of ' controllable spinal anæsthesia' with ' spinocain', which are described in the present volume.

Dr. Evans states concisely and fairly the indications for the use of spinal anæsthesia, its advantages and disadvantages, and the special precautions conducive to its successful application. As Dr. Wayne Babcock, in an introductory note, states, "It is a very personal method, strongly appealing to the temperaments of many operators, but equally unadaptable to others". Dr. Evans describes in full detail only one technique—that which has served him well in 1000 cases. Prior to the introduction of the anæsthetic solution into the subarachnoid cavity, in order to counteract the fall of blood-pressure he prefers adrenalin to ephedrine, and injects intramuscularly, into the buttocks, 1 min. of a 1–1000 solution of adrenalin for every 15 lb. of body weight. After discussing the relative merits of cocaine, tropacocaine, stovaine, apothesine, and novocain, Dr. Evans decides in favour of a preparation of novocain known as neocaine. The technique of introduction of the anæsthetic solution is fully detailed, and in Chapter 5 the accompanying phenomena—extent and duration of the anæsthesia, the fall in blood-pressure, the slowing of the heart, the respiratory depression, the lumbar puncture headache, and the increased peristalsis—are all physiologically explained.

The recognition of complications and the measures employed for their prevention are well described, and the causes of failure carefully analysed. Though Dr. Evans is obviously an enthusiast and views the subject through rose-tinted spectacles, yet his book is a most valuable contribution to a subject of great and increasing importance at the present time. The work is well illustrated.

The Treatment of Fractures and Dislocations in General Practice. By C. Max Page, D.S.O., M.S. (Lond.), F.R.C.S., Surgeon to St. Thomas's Hospital, etc. ; and W. Rowley Bristow, M.B., B.S. (Lond.), F.R.C.S., Surgeon to the Orthopædic Department, St. Thomas's Hospital, etc. Third edition. Demy 8vo. Pp. 284 + xiii, illustrated. 1929. London : Oxford University Press. 14s. net.

This edition differs from the second only in being slightly larger. Its chief improvement is the introduction of very clear line drawings alongside the X-ray reproductions which are not very clear. We cannot help thinking that the substitution of similar line drawings for all the X-ray photographs would be an improvement. The main feature of the book is that it follows the practice of the authors, and, as such, illustrates clearly the uses and limitation of plaster-of-Paris in the treatment of fractures. When dealing with this form of treatment, the writing is direct and the note sure, but the descriptions of, and indications for, most kinds of splint treatment are not so good.

The chapter on the operative treatment of fractures is most disappointing. While in a book written for the use of general practitioners no details of the various methods in use should be included. we cannot help thinking that the authors have not realized the importance of impressing upon the general practitioner the principle that early operative treatment is absolutely essential for certain fractures. This particularly applies to intra-articular fractures, and fractures of such bones as the carpal scaphoid. The latter is not mentioned in the chapter devoted to operative treatment, and where it is dealt with, the prognosis and advice as to operative treatment are very undecided. We cannot agree that open reduction without internal fixation has a somewhat limited application. When writing that the chief indication for its use is a fracture-separation of the lower epiphysis of the humerus, it is to be concluded that a supracondylar fracture is meant, as there is no detailed account of epiphysial separations.

It is unfortunate that the only two radiographs showing the application of Lane's plates demonstrate appalling results. We cannot help thinking that a more clear-cut description, founded upon personal experience, of the indications for and use of open reduction would have been of great use to many practitioners. We

cannot agree with the statement on page 110, that fractures about the elbow should be treated in a position of 40 degrees flexion. No warning is given in connection with the treatment of these fractures of the danger of immediate reduction and fixation in flexion. The authors have not yet realized the educative value of reduction of most fractures under an anæsthetic on the X-ray table. Six months' experience of the treatment of elbow fractures under these conditions would convince them that once reduction has been obtained, fixation in full flexion is usually unnecessary.

We cannot see 'eye to eye' with the authors in preferring to pass a pin for axial traction over, rather than through, the os calcis ; and similarly, we cannot help thinking that their unfortunate experience of transfixion of the condyles of the femur by a pin for axial traction has been unusual. These are, of course, only minor differences of experience.

The treatment of fractures of the spine with cord injuries is so largely the prevention of renal infection, that something more than a few lines would be helpful in contrasting the different treatments for retention. This section of the book suffers from being much condensed.

On the whole, the book will serve its purpose. It is for the most part candid and practical, so that in many respects it satisfies the needs of a practitioner faced with a difficult fracture. As a rule space is given to consideration of common injuries, both in letterpress and figures. We are confident that this edition will have as brief, and as successful, a life as the last.

Le Diagnostic dans les Affections de la Colonne vertébrale (chez l'adulte). By Professors P. OUDARD, A. HESNARD, and H. COUREAUD (Toulon), with a Preface by Professor SICARD. Medium 8vo. Pp. 256, with 75 illustrations. 1928. Paris: Masson et Cie. Fr. 36.

THIS small monograph represents chiefly the application of modern methods of diagnosis to the problems of disease or deformity of the spine. Radiology and the information derived from the injection of lipiodol now represent the last word in accurate diagnosis of the nature, position, and extent of lesions of the vertebral column. The instinct of the clinician and his interpretation of physical signs and symptoms are now to be supplemented by the precise information derived from modern scientific methods.

The main part of the work, descriptive of normal anatomy and the morbid changes associated with tuberculous disease of the spine, is of great value, because of the simple and clear descriptions and the excellent line drawings and diagrams. The reproduction of actual X-ray pictures is not as clear as might be wished. For this reason the description of deformities of congenital or postural character is not so valuable as might be desired. This is unfortunate because it is in just such conditions as sacralization of the 5th lumbar vertebra, and its distinction from osteoarthritis, that one would naturally turn to such a monograph as this for help.

Some Principles of Minor Surgery. By ZACHARY COPE, M.S., M.D. (Lond.), F.R.C.S., Surgeon to St. Mary's Hospital, Paddington, and to the Bolingbroke Hospital. Post 8vo. Pp. 159 + xi, with 82 illustrations. 1929. London: Oxford University Press. 10s. 6d. net.

THIS book is a collection of eight papers dealing with surgical principles or certain subjects of minor surgery. The use and abuse of antiseptics is the first of these essays and in it is given a good critical account of the modern application of Listerian principles. The chief value of antiseptics in wound treatment is in dealing with grossly infected superficial wounds soon after their infliction. Acriflavine and Dakin's solution are esteemed to be of the most value. In discussing the treatment of acute inflammation and describing common mistakes in the diagnosis and treatment of acute abscess there is not much that calls for comment. The fourth chapter

is concerned with infections of the fingers, and due importance is given to Kanavel's work. By means of superimposed transparent films useful diagrams are given showing the relation of the palmar connective-tissue spaces to the better defined structures of the hand. Chapters 5 and 6 describe sprains and the ambulatory treatment of fractures. So many different injuries are described, and these so briefly, that it may be questioned whether these chapters are of great practical value. For instance, the so-called sprain of the sacro-iliac joint is dealt with in less than one page, and sacrolumbar sprains in an even shorter space. In injuries of the shoulder and humerus the value of an abduction splint is not mentioned, although this is surely the most important appliance in many such conditions. In speaking of supramalleolar and malleolar fractures, it is perhaps unfortunate that, although in the text it is mentioned that the foot should be placed at right angles to the leg, yet in all the pictures of the plaster-of-Paris splint and its application, the foot is shown in a dropped position.

The next chapter describes the treatment of retention of urine, due to an enlarged prostate, by means of catheters or suprapubic puncture of the bladder, and very great stress is laid on the importance of emptying the distended bladder gradually. The concluding chapter deals with a variety of minor operations—for example, varicose veins, ingrowing toe-nail, and the removal of foreign bodies. We think the book would make a greater appeal if it dealt more with principles and less with details.

A Graphic Guide to Elementary Surgery. By Professor Th. NAEGELI, Bonn. Translated by J. SNOWMAN, M.D., M.R.C.P., with an Introduction by Dr. C. GARRÉ, Bonn. Royal 8vo. Pp. 206, with 322 illustrations (mostly coloured). 1929. London: John Bale, Sons & Danielsson Ltd. 12s. 6d. net.

THIS elementary picture-book of surgery is founded on the assumption that "a picture is worth more than many a thousand words", and has an introduction by the late Professor Garré explaining its purpose of impressing facts on the mind and memory by pictorial representation. We confess that the ideals aimed at have made a strong appeal to us and that we have derived much interest, and may we say amusement, from reading it. It deals only with general principles : anæsthesia, infections, wounds, injuries of bone, tumours, affections of arteries and veins, metabolic disorders, operations, grafting, and methods of examination. The main feature of the book is the composite diagrams—for example, *Fig.* 130 tells the story of pyæmia by means of a temperature chart, a diagram of the infected wound and the spread of infection, with others of the lungs, kidneys, liver, and hollow bones.

Certainly such a simple and graphic method of teaching affords a most valuable introductory book for the student or for the nurse. The method might with advantage be extended for use in a larger text-book.

Kleine Chirurgie. By Professor HANS KURTZAHN, Königsberg. Medium 8vo. Pp. 475 + viii, with 172 illustrations and 1 coloured plate. 1929. Berlin and Vienna: Urban & Schwarzenberg. Paper covers, M. 20 ; bound, M. 22.

THIS exposition of minor surgery is carried out on the usual lines of such books. Probably no two authors would agree as to the selection of subjects to be included in, or excluded from, the scope of such a work. In the present case the chief principle consists in excluding abdominal surgery or any description of major operations. Curiously enough, the one coloured plate is devoted to the illustration of a very rare condition, viz., erysipeloid affecting one finger. The description of ordinary matters of surgical technique is simple and clear. Injuries and infections of the fingers receive considerable attention, but there is no clear account of the connective-tissue spaces of the hand. The last chapter, which forms an unusual feature of current text-books, deals with prognosis after accidents, with a special view of giving expert opinion in cases arising under the Workmen's Compensation Act.

Hæmorrhoids: their Etiology, Prophylaxis, and Treatment by means of Injections. By ARTHUR S. MORLEY, F.R.C.S., Late Temporary Assistant Surgeon, St. Mark's Hospital for Cancer, Fistula, and other Diseases of the Rectum. Fourth impression, revised and enlarged. Demy 8vo. Pp. 122 + viii, illustrated. 1929. London: Humphrey Milford. 6s. net.

WITH the exception of an additional chapter at the end of the book entitled "An Improved Technique" in which the author adopts the method practised by the late Dr. J. D. Albright, of Philadelphia, and by Dr. C. Elton Blanchard, of Youngstown, Ohio, this book is practically a reprint of the former edition. We have, therefore, no further comment to make upon it except to express our regret that the author has not seen fit to delete the sentence against which we then took umbrage.

Injection Treatment of Internal Hæmorrhoids. By MARION C. PRUITT, M.D., Associate in Surgery, Medical Department, Emory University, Georgia Baptist Hospital and Grady Hospital, etc. Crown 8vo. Pp. 137, illustrated. 1929. St. Louis, U.S.A.: The C. V. Mosby Company. 12s. 6d. net.

THIS small volume, we are told by the author in his preface, represents an attempt to set down his experience with, and to show the val   ^. ''   ' ' '   ' treatment of internal hæmorrhoids. After defining the term   ·   ·   opening chapter, the author endeavours in the succeeding one to furnish the reader with a working knowledge of the surgical anatomy of the anus, anal canal, and the lower part of the rectum. Our comment upon this chapter is that these anatomical details will be found to have been more accurately described in any text-book of anatomy. Chapter 3 deals with etiology and prophylaxis ; the influence of occupation, age, sex, and heredity is also cursorily discussed. Chapter 4 represents the author's interpretation of the pathological changes which Quénu states take place according to his investigations. Chapter 5 contains a schematic arrangement in the form of a chart which is suggested as a substantial basis for the classification of hæmorrhoids. According to the author's preface, one of his reasons for writing this book was to remedy the confusion that he considers to exist in the minds of the medical profession with regard to the injection treatment of hæmorrhoids, but we are afraid that the classification which he now suggests will make confusion even worse confounded. Chapters 6 to 9 are devoted to the classification of both external and internal hæmorrhoids, their symptomatology, and their diagnosis. Chapter 10 is concerned with sphincteroscopes. Chapter 11 is replete with the opinions expressed by various authors in published papers upon the method of treating hæmorrhoids by injections. Chapter 12 describes the different solutions used by various exponents of the injection method, together with the author's technique for carrying out the treatment. The remainder of the book contains chapters upon care, after-treatment, pathological changes produced by injections, advantages and disadvantages of the treatment, contra-indications, complications, recurrences, and illustrative cases.

We can find no word of praise for this book. It is full of inaccuracies, the names even of well-known authors not escaping mutilation, as, for example, when Sir Charles Gordon-Watson's statistics are attributed to Sir Gordon Eatson.

The Injection Treatment of Varicose Veins. By A. H. DOUTHWAITE, M.D., M.R.C.P., Assistant Physician, Guy's Hospital. Fourth edition. Crown 8vo. Pp. 58 + x. 1929. London : H. K. Lewis & Co. Ltd. 4s. net.

THE author, after an experience of five thousand injections, is more than ever convinced of the great value of this method in the cure of varicose veins. Having tried various alternative solutions, he considers that the quinine and urethane solution is the best. It gives uniformly good results and produces a venitis with more firmly adherent clot than any other drug. Injection is not recommended for the treatment of varicocele.

Imperative Traumatic Surgery, with Special Reference to After-care and Prognosis. By C. R. G. FORRESTER, M.D., F.A.C.S., Consultant, Teaching Staff, Illinois Post Graduate School, Laboratory of Surgical Technique, Chicago, etc. Medium 8vo. Pp. 464 + xxix, with 598 illustrations. 1929. London : William Heinemann (Medical Books) Ltd. 42s. net.

THERE is nothing remarkable in this book beyond the title. Whilst it deals chiefly with fractures, dislocations, and injuries of peripheral nerves, it also includes housemaid's knee and acute osteomyelitis. In the case of fractures of the skull, spine, chest, and pelvis, the possible concomitant injuries to brain, spinal cord, and viscera are only briefly mentioned.

When we are told that after removal of a semilunar cartilage from the knee the patient should be able to walk without the use of an artificial support in from five to eight weeks, and that for traumatic synovitis the treatment should be immobilization of the limb in a plaster cast for six weeks, we can but regret that the hustle characteristic of American life has not been universally adopted by ' traumatic surgeons '.

Lister Redivivus. An Essay on the Undue Prevalence of Sepsis. By A. C. F. HALFORD, M.D., Honorary Consulting Surgeon, Lady Lamington Hospital, Brisbane. Royal 8vo. Pp. 110. 1928. Brisbane : Sapsford Bros. 5s. net.

THE history of the methods of treating wounds and of the antiseptic principles of surgery is a fascinating one, the epic of which still remains to be written. The beginning of the story is vague and nebulous and goes back to times earlier than our earliest records : it continues through the centuries, and even to-day universal agreement on this fundamental subject has not been reached.

More than 600 years ago, before the Battle of Crécy was fought, a famous French surgeon, Henri de Mondeville, affirmed his belief, which amounted in those days almost to heresy, that suppuration was not an essential process in the healing of a wound, and that wounds could, and did, heal by first intention, if treated by the methods he advocated and gave to the world in his book on surgery. The main principles of Mondeville's treatment, the exact reasons for which he did not appreciate, were to remove all foreign bodies from the wound, to avoid probing, to wash it with wine, to avoid exposure to the air by means of early suture, and then to cover it with compresses soaked in wine. The introduction of this novel treatment, which compares very favourably with modern aseptic principles, seems to have caused an immense commotion in medical circles. Mondeville says himself that he had much to put up with, vehement discourses, violent words, perils, and menaces so threatening that he would have abandoned it if he had not had the support of his royal patron, the Count of Valois.

It would appear that Mondeville's method was not his own, but taken from his master, Theodoric, and then elaborated and improved. But where did Theodoric get it ? The answer is not given, but the story of the Good Samaritan suggests that something like it had existed for many years. After the death of Mondeville the method was abandoned, and the great Guy de Chauliac, writing fifty years later, speaks of it with disdain. So 600 years elapsed before the illuminating discoveries of Pasteur, and their application to surgery by Lister, gave to the world the true knowledge of the cause of suppuration, and made surgery safe. These epoch-making discoveries ushered in the era of antiseptic surgery, soon to be followed by that of aseptic surgery. This great revolution, though, did not come peacefully. The doctrines of Lister were not adopted quickly and universally. Antisepsis and asepsis : the controversies on these raged to and fro, until the clouds of confusion gradually cleared, and the true meaning of the difference, or want of difference, between the methods has become evident and the medical profession has settled down with complacency to what has become an international standard method.

Now Mr. Halford, in his book *Lister Redivivus*, wonders what Lister would think if he were to come to life again and see how different the methods at present in

vogue are from the ritual he elaborated. He thinks Lister would be sad, miserable, shocked, for in his opinion the world has adopted an unsound, fallible method instead of a sound one. His thesis is that there is too much and avoidable sepsis in surgery and midwifery, all of which could and should be avoided by adhesion to Lister's own methods. From many of Mr. Halford's opinions we may dissent ; we may be irritated by his methods of argument, for he hits out hard and often, but at the same time we thank him for calling attention to a most important subject, and for the obvious sincerity and honesty of purpose which shine out from every line. The author is a man of mature age who has been for many years a general practitioner and Medical Officer of Health in Australia, and he speaks out of the fullness of his experience. His book also is introduced by Mr. Hamilton Russell, whose opinion is universally respected, who says of him in a Foreword that "it is the cry of a thoughtful and enthusiastic practitioner of medicine, prompted, I may even say goaded, to a divine discontent at the present-day usages that purport to be the modern and improved expositions of the principles of Lister."

It is not an easy book to read or review because of a lack of clear exposition, which engenders confusion of thought in the mind of the reader and, may one guess, in the mind of the writer as well. The subject raised, however, is so important, and such serious criticism is levelled at the methods at present in vogue, that the book has been read with the care it deserves and, as far as possible, without prejudice.

If we have understood the author aright, the following are the points he makes : (1) There is undue sepsis in medical practice to-day : operation wounds 'go wrong': contaminated or infected wounds, which might have been cleansed by Listerism, are allowed to suppurate : tuberculous abscesses become secondarily infected and parturient women become infected, many dying, and still more undergoing long and painful illnesses. (2) All these could be prevented by using Lister's methods. (3) The modern usage of dressings and instruments sterilized by heat, and without the use of 'antiseptic' chemicals, does not prevent contamination of the wound, either at the time of operation, or in the post-operative period of dressing and convalescence, or in the puerperal or post-puerperal period.

These seem to be the main arguments employed when dissected out of the mass of observations and objurgations contained in Lister Redivivus. If these points are examined it seems clear that most, if not all, will at once agree that there is still a regrettable amount of sepsis. What surgeon can deny that sometimes an operation 'goes wrong' ? What obstetrician can say that he never sees a case of puerperal sepsis in his practice ? Conceding these points, the main argument has to be examined. Would there be less sepsis if all wounds, and all midwifery cases, were treated by Lister's methods, as Lister used them ? Mr. Halford thinks there would. There seems to be a very large body of opinion of a contrary character. Is it not clear that a clean wound is to be kept free from contamination with micro-organisms ? Is it not better to take such steps as will ensure that none get in rather than to kill them once they have got in ? From the point of view of clean operation wounds, surgeons have arrived at the opinion, on good and sufficient grounds, that sterilization of instruments and dressings by heat, and protection from infection of hands and mouth by gloves and masks, give good results.

The treatment of accidental, already contaminated, or infected wounds may be considered more open to argument. Mr. Halford points to the terrible amount of suppuration seen in the Great War, and infers that all the dreadful sights revealed then to military surgeons might have been banished by Listerism. He says : "How powerless aseptic surgery was under these new conditions we can read in the medical records of the Army Medical Services. What is most remarkable about these reports is the ultimate conclusions of the most energetic research workers, that the most that could be done was to subject all infected wounds to continuous irrigation with an antiseptic for long periods." It is true that we were a long time controlling sepsis in war wounds, but this was largely due to the conditions of warfare which compelled wounded to be brought back to the base, and thus delayed treatment for days. In the later stages of the war, things were very different. One of the most

important and fundamental pieces of research was done and published by the late Forbes Fraser: "Primary and Delayed Primary Suture of Gunshot Wounds: A Report of Research Work at a C.C.S." (Brit. Jour. Surg., 1918, vi, 92). This work seems to answer in most respects these criticisms, and though these remarks may perhaps not convince Mr. Halford, they may serve to show him that there is at least another side to the shield. He may be pleased to think that his criticisms may, as they certainly should, cause every surgeon to pause and ask himself if he is doing all he ought. If this results, then the book is justified, and Mr. Halford may be to surgery, as the pearl to the oyster, a precious irritant.

Indigestion: Its Differential Diagnosis and Treatment. By HERBERT J. PATERSON, C.B.E., M.C., M.D., M.A. (Cantab.), F.R.C.S., Senior Surgeon, London Temperance Hospital. Pott 4to. Pp. 153 + viii. 1929. London: William Heinemann (Medical Books) Ltd. 7s. 6d. net.

IN this book the author has endeavoured to present a practical guide to the differential diagnosis and treatment of indigestion. As the book is intended for clinical use and not for historical research, references to statistics, etiology, and pathology have been omitted, except in so far as is necessary for an adequate understanding of the subject. He first of all attempts a classification of disorders of digestion; this is followed by a chapter on clinical investigation in which he rightly emphasizes the outstanding importance of the history. Under the heading of physical examination a good deal of space is devoted to test-meals and their significance, the author believing that in their proper place such investigations are a great help in the diagnosis of the causes of indigestion. We think that he over-stresses the value of test-meals; gastric analysis cannot be other than an inexact bio-chemical procedure, for not only are the normal variations very elastic, but these variations themselves depend on factors which are constantly changing, and of these the psychic factor may be of great importance, depending as it may upon the reaction of the patient to the extreme unpleasantness of the passage of the stomach tube. In the chapters dealing with gastric and duodenal ulcers and cancer of the stomach we find a repetition for the most part of the descriptions to which we have become so accustomed in the literature, and the same may be said of the chapter on complications.

Under the heading of surgical treatment of duodenal ulcer the author asserts that gastrojejunostomy is a physiological operation; we presume he means by this that it is a chemical, as opposed to a mechanical procedure; for an operation which removes the emptying point of the stomach out of the line of the peristaltic drive of the muscle can hardly be termed physiological. We think the value of his assertion would have been enhanced if he had produced arguments to show that the mechanical factor of a new opening has no significance. The book terminates with a short chapter on the general treatment of disorders of digestion, and an appendix in which various tests, qualitative and quantitative, are described.

On the whole the book fulfils its purpose as a practical guide to the differential diagnosis and treatment of indigestion, but we do not think the author is serving any very useful purpose in presenting it. The matter it contains has already been published in book form on very similar lines; there is nothing new in it, and nothing to stimulate thought along fresh channels. The author is so well known as an authority on gastro-intestinal disorders that we confess to a feeling of disappointment that he should have presented a book which does not carry us any farther than we were ten or fifteen years ago.

Chirurgie de l'Articulation temporo-maxillaire. By L. DUFOURMENTEL, Professor of Maxillo-facial Surgery in the Dental School of France. Medium 8vo. Pp. 228 + x, with 69 illustrations. 1929. Paris: Masson et Cie. 6s. 6d. net.

THIS monograph deals with a subject which enters the province both of the general and of the dental surgeon. The temporo-maxillary joint is difficult to examine either

by palpation or by radiographs, and the latter can only be interpreted with difficulty. The diagrams of the anatomy of the joint are good and clear, although the sub-division of the ligaments is depicted as being much more distinct than is really the case. Arthritis, acute or chronic, and trismus are described fully and on usual lines. The most interesting and valuable chapters are those relating to deformities of the condyle, prognathism, and ankylosis. The treatment of prognathism by resection of the condyle on each side is very interesting, but is open to two critical remarks. What is the late result of excision of both condyles? One would like to know the condition, as regards movements and mastication, five years after the operation. The other point is that, judging from the accompanying illustrations, the amount of prognathism was hardly enough of a deformity to justify the operation in some of the cases.

The chapter to which the general surgeon will turn most frequently is that on ankylosis of the joint. The author claims to have operated upon more then fifty cases with only three recurrences. The line of the articulation is cut by means of a number of adjacent drill-holes and the surfaces are smoothed off. No attempt is made to interpose either muscle or foreign material, and the wound is closed without drainage. Great reliance is placed upon the use of an apparatus (Darcissac) by which almost constant immobilization of the jaw is achieved. This consists of two levers fixed to the two jaws and so activated by an elastic spring as to keep the jaws open. The patient will close the jaw in the act of speaking or swallowing, so that the articulation is kept constantly moved.

Branchial Cysts, and other Essays on Surgical Subjects in the Facio-cervical Region. By HAMILTON BAILEY, F.R.C.S., Surgeon to the Dudley Road Hospital, Birmingham, etc. Crown 8vo. Pp. 86 + viii, with 50 illustrations. 1929. London: H. K. Lewis & Co. Ltd. 5s. net.

THIS short collection of essays on subjects relating to the surgery of the neck is of definite practical value. The diagrams of the possible situation and relations of branchial cysts, which have already appeared in this JOURNAL, are clear and simple.

It is rightly maintained that a correct diagnosis can be made in most cases before operation. Stress is laid on the characteristic appearance under the microscope of the fluid withdrawn by puncture. It always contains cholesterin crystals and epithelial débris. A good description is given of the complete operation for the removal of the thyroglossal tract, after division of the hyoid bone. The complications and diagnosis of a submaxillary calculus form the theme of another interesting chapter. The last chapter is on the preventive treatment of cavernous sinus thrombosis in cases of carbuncle of the upper lip. This, consisting in the ligature of the angular vein, was done in four cases, three of which made a good recovery. The subject is one very inadequately dealt with in current surgical text-books, and the present volume is decidedly opportune.

Le Tractus thyréoglosse. By G. RÉMY NÉRIS, Ancien Interne lauréat des Hôpitaux de Paris (Prix d'Otologie). Medium 8vo. Pp. 170, with 23 illustrations in the text. 1929. Paris: Gaston Doin et Cie. Fr. 30.

THIS prize essay brings together in a very convenient and readable form the salient facts about the embryology, pathology, and treatment of cysts, fistulæ, and tumours of the thyroglossal tract. The very intimate relationship of the budding thyroid duct to the hyoid bone in early development is well shown by a number of sections of embryos. This point is of cardinal importance in understanding the persistence of fistulæ and the recurrence after operations upon cysts. It forms the basis of the Sistrunk operation, which is figured and described, the hyoid bone being divided in

order that the whole tract up to the foramen cæcum may be removed. A small quiescent cyst not causing symptoms should be left alone. The drawings and microscopical sections are very clear and convincing.

Gelenkerkrankungen. Einführung in die Pathologie und Therapie. By Dr. ERNST FREUND, Vienna. Royal 8vo. Pp. 497 + xii, with 88 illustrations in the text. 1929. Berlin and Vienna : Urban & Schwarzenberg. Paper covers, M. 32 ; bound, M. 35.60.

THIS book, which aims at giving an introduction to the pathology and treatment of joint disease, is a general survey of the subject written by a physician. He is fully aware of the size of his subject and its many complexities, and he strives to bring together the many workers and the results of their labours in this compact and practical book. It makes no pretensions to be a surgical text-book. In fact there are only two pages devoted to surgical treatment. But the author makes a strong and an unanswerable appeal for closer co-operation between the physician and the surgeon, in order that knowledge of the scope and results of surgical intervention may be better appreciated.

The book is remarkable rather for the large number of subjects with which it deals than for the completeness with which any one subject is discussed. Every possible disease in which the joints are affected is described. The influence of metabolic disorders, nervous diseases, and diseases of the endocrine glands is discussed at some length. There is a summary of all the methods of treatment, with a short indication of the scope of each. The illustrations, which are not very numerous, are good and clear, but their value would be greatly increased by the addition of an appropriate legend to each, instead of compelling the reader to search for the reference in the text.

Die Vor- und Nachbehandlung bei Chirurgischen Eingriffen. By Dr. M. BEHREND. Second edition. Post 8vo. Pp. 115, with 5 illustrations. 1929. Berlin : Julius Springer. M. 4.80.

THE appearance of a second edition of this small and practical book so soon after the first is sufficient evidence that it has been found of value. It is remarkable how much is contained in so small a compass. For this reason and also because of its completeness and simplicity it will probably continue to prove of value to students, nurses, and house surgeons, in reminding them of special precautions to be taken before operations, and special treatment necessary afterwards.

Œsophageal Obstruction : its Pathology, Diagnosis, and Treatment. By A. LAWRENCE ABEL, M.S. (Lond.), F.R.C.S., Assistant Surgeon to the Cancer Hospital, London. Super Royal 8vo. Pp. 234 + xi, illustrated. 1929. London : Humphrey Milford. 30s. net.

THIS book incorporates the Jacksonian Prize Essay of 1925 revised, enlarged, and brought up to date, and a Hunterian Lecture delivered in 1926. It is well and profusely illustrated, and is written in an easy and entertaining style. It appears to contain an account of all that is known about the œsophagus—its anatomy and deformities ; the methods by which it should be examined ; its functions, both natural and perverted ; and a detailed account of its diseases. Its tone is essentially practical, and the author gives a very lucid and concise idea of his own opinions, as well as mentioning the various alternative theories and methods. At the end of every chapter is a most extensive bibliography, and this feature in itself renders the book very valuable for reference. While it cannot be claimed that there is anything strikingly original in the book, yet it must be appreciated as a most exhaustive account of the present state of knowledge of the œsophagus. In regard to the great problem—the treatment of carcinoma—the author has nothing very encouraging to offer. Radium is mentioned as a possible palliative agent, but all his faith is pinned on excision of the growth. It is suggested that the difficulties presented by operations upon the stomach and colon are strictly comparable with those in the case of

the œsophagus, and that, just as these difficulties have been overcome in the former, so, given "more adequate education and earlier investigation of cases", they may be overcome in the latter. We must be pardoned if we assert that Mr. Abel's statement that under these conditions malignant disease of the œsophagus "will be the most favourable type of cancer with which the surgeon has to deal" appears more like a pious hope than a justifiable conclusion.

Le Cancer primitif du Poumon : Étude anatomo-clinique. By René Huguenin, Ancien Interne lauréat des Hôpitaux de Paris. Preface by Dr. G. Roussy. Royal 8vo. Pp. 330 + iv, illustrated. 1928. Paris : Masson et Cie. Fr. 50.

This is a monograph dealing with primary carcinoma of the lung from an anatomical, pathological, and clinical point of view. The author describes the sites and appearances, macroscopic and microscopic, of the different forms of carcinoma. He describes the course of the disease, the clinical features, the methods of diagnosis, and finally the forms of treatment and the results of radiotherapy. A useful bibliography is attached.

Les Abcès du Poumon. By Michel Léon-Kindberg, Médecin des Hôpitaux de Paris. Crown 8vo. Pp. 134, illustrated. 1928. Paris : Masson et Cie. 1928. Fr. 14.

This is one of the manuals of practical medicine and surgery which are published from time to time by the house of Masson. The author discusses in a useful and concise manner the etiology, diagnosis, pathology, and treatment of pulmonary abscess. It is a very useful résumé of the subject, and has a good bibliography.

Le Cancer : Maladie des Cicatrices. By Auguste Lumière, Correspondant de l'Institut ; Correspondant de l'Académie de Médecine. Preface by Professor L. Bérard, Membre Associé de l'Académie de Médecine, etc. 8vo. Pp. 287 + ix. 1929. Paris : Masson et Cie. Fr. 18.

The author gives a comprehensive analysis of the literature on the etiology and treatment of carcinomata, and bases his own theories on the conclusions which he draws. Tumours are divided into four groups : (1) Inflammatory hyperplasias ; (2) Tumours developed in persistent embryological cell nests ; (3) Tumours of connective tissue ; (4) Malignant epithelial tumours. It is the fourth group which forms the subject matter of this book. The author believes that four conditions must be present before a malignant epithelial tumour can develop : (1) Delay in the healing of an injury, and the formation of a cicatrix ; (2) A latent period of about twenty years ; (3) Secondary trauma to the cicatrix to start off the malignant process ; (4) A suitable humoral medium. This theory is summed up in the phrase of ' no cicatrix, no cancer'. Doubt is cast upon the value of statistics based on death certificates, and also upon any theory invoking a bacteriological cause of cancer.

The Medical Museum : Modern Developments, Organization, and Technical Methods based on a New System of Visual Teaching. By S. H. Daukes, O.B.E., M.D., D.P.H., Director of the Wellcome Museum of Medical Science, affiliated to the Bureau of Scientific Research. An amplification of a Thesis read for the degree of M.D., Cambridge. 10 in. × 7 in. Pp. 172, illustrated. London : Wellcome Foundation Ltd. Printed for private circulation.

The Wellcome Historical Medical Museum in Wigmore Street, London, W., is known to most medical men ; it is a unique treasure house of specimens and documents which illustrate the history of medicine. The Wellcome Museum of Medical Science is almost unknown, and yet for medical men it is far more important than the

other, for it seeks to give a graphic representation of the present state of modern medicine. This great addition to the medical institutions of London has grown up so quietly just off the bustle of Euston Road that its existence has almost escaped notice. The book which its curator, Dr. S. H. Daukes, has written about it is thus most opportune.

There is no doubt about it that in the opinion of most practitioners the museums attached to medical schools have outlived their period of usefulness and might well be scrapped. This opinion is also shared by many teachers, particularly those who have to do with the experimental branches of medicine. There is something wrong with medical museums, and the question which many are asking is : How can they be made alive ? Dr. Daukes has not only asked this question ; he has answered it by bringing into being—through the unstinted generosity of Dr. Henry Wellcome —a great medical museum of a new kind and based on novel lines. Dr. Daukes holds the opinion that pathological specimens can serve a useful purpose in medical education only when they are given their proper setting. They must not be separated from the picture of the patient and his disease. Take a case of endocarditis ; the heart with the aortic valves studded with vegetations is shown, but with it is given the photograph of the sick boy from whose body the specimen came. The temperature chart and pulse-rate are shown beside the patient. A graphic picture of the heart symptoms is set beside the chart. With the case is placed the boy's tibia— the site of an acute osteomyelitis. Cultures of organisms grown from the tibia and blood form part of the exhibit. In brief, Dr. Daukes's aim is to make the medical museum the central department of a medical school where all branches of knowledge are made to focus their combined efforts to unravel the nature of a disease, exemplify its symptoms, give the means of diagnosis, set forth graphically the modes of treatment, and, where possible, illustrate the methods of prevention. Some diseases lend themselves to this graphic method of illustration better than others. Tuberculosis and syphilis may be taken as examples. Both these diseases are fully illustrated in the new museum by means of photographs, drawings, models, and actual specimens ; the modes of infection, the infective organisms, their isolation and identification ; the symptoms, diagnosis, treatment, and prevention are all portrayed. The visitor, be he layman, medical student, or medical practitioner, has set before him a graphic representation of all that is known concerning these particular diseases. The whole field of human disease is brought within the scope of this new museum.

The merits of such a system are obvious ; but we must not forget that its attainment is difficult and costly. Not everyone has the resource and happy ingenuity of Dr. Daukes in designing the means which will bring before the student the full story of a disease told graphically ; only institutions which can command artists, modellers, and technicians are in a position to undertake such a scheme. Medicine is progressive ; every day sees an addition to knowledge, and the exhibits have to alter as knowledge grows. There has to be a continuous struggle to keep up to date ; there have to be repeated periods of scrapping ; there must be almost unlimited space for exhibition, and apparatus of the most costly kind. There must be a most liberal supply of expensive cases and of exhibition stands. Labels have to be changed or improved. Literature has to be surveyed and abstracted month by month ; a great and efficient staff has to be maintained. Granted all these conditions, with an inventive and resourceful brain behind all, such a desirable national institution as the Wellcome Museum of Medical Science becomes possible. Such a museum is a great engine of medical education, and represents medical propaganda of the best kind. Clearly, to carry out such a scheme in its complete form is beyond the financial resources of most medical schools ; but without a doubt it is an ideal which every school should aim at.

Dr. Daukes is also alive to another function of museums beyond that of educating medical students. They are also institutions which have to do—or should have to do—with the increase of knowledge. They should cater not only for the needs of students proceeding to examination, and the needs of men in practice, but also for the needs of men who are engaged on research. For research the graphic illustration of current knowledge is useless ; only original documents—the actual specimens—

are of value. The research museum and the teaching museum have to serve different purposes and must be organized on separate lines. That is no reason why our larger museums should not aim at serving both purposes, but it would be a misfortune if the possibilities of museums as powerful instruments of research were lost sight of.

Dr. Daukes's book, excellently printed, gives a history of the Museum he has done so much to create. It does more : it supplies curators of medical museums with much technical information for which they will be grateful.

A Surgical Diagnosis. By J. L. DONHAUSER, A.B., M.D., F.A.C.S., Clinical Professor of Surgery, Albany Medical College (Union University). Royal 8vo. Pp. 799 + xxvii, illustrated. 1929. New York and London : D. Appleton & Co. 42s. net.

THE purpose of this book is to set forth systematically and in great detail the methods—history-taking, clinical examination, and laboratory and radiological data—whereby a diagnosis may be established in the surgical conditions affecting all parts of the body. It is based on nearly twenty years' experience in the teaching of surgical diagnosis, and is intended primarily for students, but also for house officers and general practitioners. It is a very thorough and comprehensive work, the compilation of which has entailed much labour. It is a monumental example of one method of clinical teaching, the 'list' method, which appeals to some, but certainly not to all intellects. The student who sets out to learn clinical surgery by preparing lists of all the possible diseases of every individual organ will revel in this book to his heart's content, for these lists are irreproachable in their complete-ness. Their appalling length will, however, fill with dismay a mind not so pigeon-holed ; and they will leave unmoved the student who is pinning his faith to an underlying uniformity in pathology in all organs, modified here and there by the anatomical or physiological peculiarities of the affected part.

The contents are divided up into twenty-four sections, ten of which deal with abdominal surgery, four with conditions affecting the extremities, and the remainder with diseases of the head, neck, thorax, urogenital system, the general consideration of the examination of patients, the infections, and the tumours. In each section a complete list of all the diseases affecting that part is given, and in the following pages a few paragraphs are devoted to each disease in turn, with a brief description of the salient features differentiating it from the others. At the end of most of the sections there is a large table of differential diagnosis. Most of these tables are too cumbersome and complicated to be instructive. One feels that the object of the author has been to leave nothing out, and one fears that his success renders the book too burdensome for the average student. Except for those capable of incredible feats of memory, it is more likely to be of value as a book of reference than as a text-book.

Medical Adventure : Some Experiences of a General Practitioner. By Dr. ERNEST WARD, M.D. (Cantab.), F.R.C.S. Crown 8vo. Pp. 291, with 10 illustrations and a por-trait of the Author. 1929. London : John Bale, Sons & Danielsson, Ltd. 8s. 6d. net.

THE present volume deserves a warm welcome from all medical readers. It repre-sents a much more serious contribution to medical literature than is implied by its title. Many of the chapters are articles written for the *London Hospital Gazette* to bring before students the realities of general practice. The great value of the articles consists in the fact that they are the outcome of real experience, and that the problems are viewed from the point of the man in family practice. Chiefly they deal with commonplace diseases—for example, measles or mumps—and there is a preponderating number of chapters on skin diseases, both rare and common. The few chapters on surgical subjects are all full of acute observation and are illuminated by great humour. As an example of this, in the chapter on carcinoma of the rectum we are told of a case of apparently hopeless ulcerating growth of the bowel

which was cured by anti-specific remedies. The patient celebrated his recovery from imminent death by attending no fewer than three 'revival meetings' in one day. We wish that Dr. Ward would give us further articles dealing with the diagnosis, treatment, and results of surgical conditions, as seen by the family doctor.

Catalogue of Lewis's Medical and Scientific Circulating Library. Part I, Authors and Titles. Part II, Classified Index of Subjects, with Names of Authors who have written upon them. Revised to the end of 1927. Demy 8vo. Pp. 576. 1929. London : H. K. Lewis & Co. Ltd. 15s. net. (To Subscribers 7s. 6d. net.)

MESSRS. LEWIS have carried out a work of great value and importance in the foundation of their circulating medical library. By this means many an isolated practitioner has been able to get at otherwise inaccessible books, and also the smaller medical libraries can greatly enlarge the scope of their usefulness by affiliation with this organization. The present catalogue is not only a list of all the books available, but is accompanied by an index showing which books are available on any particular subject, and the author's name and date of publication. This catalogue and index greatly enhance the value of Lewis's library.

Guy's Hospital Reports. Edited by ARTHUR F. HURST, M.D. Vol. LXXIX (Vol IX, Fourth Series), No. 1, January, 1929. Medium 8vo. Pp. 126, illustrated. 1929. London : Lancet Ltd. 12s. 6d. net.

AMONGST other articles this number contains : " Notes on the Etiology of Appendicitis ", by W. H. Bowen, in which the author concludes that the main etiological factor in appendicitis is stagnation in the appendix ; " Hydatid Cyst of the Kidney ", by R. P. Rowlands ; and " Visualization of Bile-ducts after an Opaque Meal ", by J. F. Venables.

Report on Fourth International Congress of Military Medicine and Pharmacy, Warsaw, Poland, May–June, 1927. By COMMANDER W. SEAMAN BAINBRIDGE, C-F., United States Naval Reserve ; Member of Permanent Committee. Demy 8vo. Pp. 248 + ix, illustrated. 1927. Wisconsin : The Collegiate Press.

THIS report has been compiled, presumably for the American Government, by a member of the Permanent Committee. It is difficult to assess the status of an International Congress to which France sent over 70 delegates, Great Britain 7, and the United States 5.

It is clear that subjects of fundamental interest in military medicine were under discussion, including the evacuation of wounded, head injuries with all their complications and sequelæ, and the therapeutics of the arsenobenzols. Apart from the immense range of these different subjects, it is difficult to assess the value of the conclusions of the Congress, because no one of the British delegates can boast of large clinical experience of the subjects under discussion.

It would seem that the vision of Belgium, who called the first Congress in 1921, has been amply justified, but if the delegates at these Congresses are granted opportunities of self-education in the care of the sick and wounded, it is not easy to understand why the representatives from Great Britain are limited solely to regular members of the three services.

Reflections and Operations. By Sir JOHN O'CONOR, K.B.E., M.A., M.D. (Dublin), late Senior Medical Officer, British Hospital, Buenos Aires. Edited by BEATRICE and MAY O'CONOR, with a Foreword by HERBERT J. PATERSON, C.B.E., M.C., M.D. (Cantab.), F.R.C.S., Senior Surgeon, London Temperance Hospital. Demy 8vo. Pp. 361 + xxxvi, with 4 plates. 1929. London : Baillière, Tindall & Cox. 21s. net.

OVER twenty-five years ago the reviewer, like many others, was attracted by the writings of O'Conor, of Buenos Aires, and now welcomes the collection of his numerous published papers in one volume. O'Conor left England for the Argentine

in 1889 as doctor to a mining company, on the failure of which he was appointed House Surgeon to the British Hospital in Buenos Aires, soon becoming its Senior Medical Officer—a position he retained until his death.

Few young surgeons can have had such unrivalled opportunities of major surgery, and O'Conor soon proved his worthiness to be entrusted therewith. He was a 'general' surgeon in the widest sense of the term, and his writings, covering practically the whole field of surgery, display marked originality, extraordinary breadth of view, clear thinking, concise description, sound common- : ' . '   · ' ·:arless criticism, and hatred of all shams. His great practical , · · ·   .   , his unusually dogmatic style in teaching, and everywhere his writings abound in most useful practical hints and 'tips'. Many of his views run counter to those usually regarded as orthodox—for example, his preference for anterior rather than posterior gastro-enterostomy, his rule "never to quit the abdomen in acute appendicitis without removing the appendix", his strictures upon the use of early massage and movement in the treatment of fractures, and his spirited defence of Whitehead's operation for hæmorrhoids. Moreover, his advocacy of alcohol both as an article of diet and in the treatment of disease would not be approved by our numerous temperance associations. No one can fail to enjoy and to be encouraged by a perusal of this volume, and to be the better for the introspective self-criticism it must spontaneously evoke.

EPOCH-MAKING BOOKS IN BRITISH SURGERY.

By Sir D'ARCY POWER, K.B.E., LONDON.

XI. "MY BOOK" BY JOHN ABERNETHY.

JOHN ABERNETHY was the first of the great English surgeons of the last century to treat his patients by expectant means rather than by operation. He thus founded a school of British surgery based upon physiology rather than anatomy. The idea was fundamentally sound, but Abernethy was a pioneer, and as we now read his works it is easy to see how extraordinarily inadequate was the foundation upon which he built. He had no knowledge of physiology in the modern sense; his pathology was crude; he was ignorant of the part played by micro-organisms in disease; and when syphilis was rife he did not recognize either its later lesions, which we now call tertiary, or its hereditariness. Yet by sheer genius his conclusions are often correct, and later surgeons accepted the basis though they modified the teaching.

Abernethy put forward his theories in a book which he always spoke of as " My Book ". It was rarely out of his thoughts. He spoke of it to his pupils, he dragged it into every lecture, he presented it to his patients. His classes were large and his patients many, so that " My Book " became one of the best-known works in the early part of the nineteenth century, and it was known officially as a treatise " On the constitutional origin and treatment of Local Diseases ". It first appeared in 1806 under the title of " Surgical Observations, Part the second, containing an account of the disorders of the health in general and of the Digestive Organs in particular which accompany local diseases and obstruct their cure ". The 2nd edition appeared in 1811, the 3rd in 1814, the 4th in 1817, the 5th in 1820, the 6th in 1822, the 7th in 1824, the 8th in 1826, the 9th in 1827, the 10th in 1827, the 11th in 1829, and Abernethy died in 1831.

The main thesis advanced by Abernethy was that errors of digestion were the *fons et origo* of many surgical disorders and that diet, gentle purging, and an open-air life would cure many of the conditions generally met with in surgical practice. This was probably true, for during the life of Abernethy the well-to-do habitually over-ate themselves, took but little exercise, drank a

great deal, and were usually constipated; whilst the poor were disgracefully housed, were indigent beyond conception, and were for the most part drunken. Neither rich nor poor were aware of the value of fresh air. He says :—

"Nothing in Pathology is more generally admitted than the reciprocal operation of disorders of the head and of the digestive organs on each other; yet the exceptions to this general rule deserve to be remarked in a comprehensive examination of the subject. Some persons have great disorder of the digestive organs without any apparent affection of the nervous system; and even diseases of a fatal nature may take place in the former organs without affecting the latter. Indeed if we examine any of the most evidently sympathetic affections we shall find the same exceptions. The stomach generally sympathizes with disorder of the uterus but it does not invariably do so.

"Many of the symptoms recorded in the description of the state of health of those persons who are affected by disorder in the digestive organs denote a disturbance of the nervous and muscular powers. When we observe this compound disorder we can seldom determine which were the primarily affected organs. The history will generally show that the derangement of the digestive organs is secondary. When it arises from local irritation, it can be produced only through the medium of the sensorium. When it is idiopathic it frequently originates in causes which affect the nervous system primarily, such as anxiety, too great exertion of mind or body and impure air. Sedentary habits and irregularities of diet are causes which may be supposed to act locally on the digestive organs themselves. Nervous irritability and weakness are not perhaps susceptible of a direct cure by medicine; but the disorders of the digestive organs are more corrigible by medical remedies. In practice these require our chief attention, and if their disorders be corrected all nervous irritation frequently ceases and health is restored. In many instances the nervous irritation which has induced the disease is trivial and would soon cease were it not kept up by the reaction of its effects.

"Whether this disorder of the digestive organs be primary or secondary it generally produces irritation in the brain; and thus may cause in many instances actual disease of that organ. The connection of local disease with general disorder has often been remarked; it has formerly been attributed to impurity of the fluids; a theory which is not irrational. Imperfect digestion must influence the qualities of the blood and all parts of the body may be affected from this source. But in accounting for the reciprocal influence of disorders of the head and the digestive organs on each other, the modern explanation of these phenomena by means of sympathies is perhaps preferable. Afflicting intelligence will destroy the appetite and produce a white tongue in a healthy person; a blow on the stomach disorders the head. These phenomena take place independently of the blood and can only be explained by admitting that disturbance of one organ immediately affects the other."

There is no doubt that Abernethy rode his hobby too hard, but he drew attention to the influence which the general health exercises over local conditions, and thus in some vague way seems to have foreshadowed the doctrine of immunity. He says about treatment :—

"I do not feel altogether competent to give full directions relative to this subject because I have never attended to medical cases with that degree

of observation which would lead me properly to appreciate the efficacy of different medicines when administered either in their simple or compounded forms." He gives, however, some simple rules as to diet, saying about food: " First, with respect to quantity. There can be no advantage in putting more food into the stomach than it is competent to digest, for the surplus can never afford nourishment to the body ; on the contrary, it will be productive of various ills. Being in a warm and moist place the undigested food will undergo those chemical changes natural to dead vegetable and animal matter, the vegetable food will ferment and become acid, the animal will grow rancid and putrid. . . . Nature seems to have formed animals to live and enjoy health upon a scanty and precarious supply of food ; but man, in civilized society, having food always at command and finding gratification from its taste and a temporary hilarity and energy result from the excitement of his stomach, which he can at pleasure produce, eats and drinks an enormous deal more than is necessary for his wants or welfare. He fills his stomach and bowels with food which actually putrefies in those organs. He fills, also, his bloodvessels till he oppresses them and induces diseases in them as well as in his heart. . . . In proportion as the powers of the stomach are weak so ought we to diminish the quantity of our food and take care that it should be as nutritive and easy of digestion as possible.

" Secondly, as to quality ; It is not my intention to discuss the question as to the nature of the food proper to mankind but I may observe that its qualities should be adapted to the feelings of the stomach. In proof of this numerous instances might be mentioned of apparently unfit substances agreeing with the stomach, being digested and even quieting an irritable state of the stomach merely because they were suitable to its feeling. Instances might also be mentioned of changes in diet producing a tranquil and healthy state of stomach in cases where medicines had been tried in vain.

" Thirdly, as to the times of taking food. It is evidently the intention of nature that we should put into the stomach a certain portion of food, the excitement of which inducing a secretion of gastric fluid by its action becomes digested. This office of the stomach being effected it should be left in a state of repose till its powers are restored and accumulated, and this return of energy would, in a state of health, be denoted by a return of appetite. It is therefore reasonable to allot the same portion of time for the same purpose when the organ is disordered whilst we have diminished the quantity of our food in order to proportion it to the diminished powers of the organ ; yet instead of pursuing this rational plan of diet many persons are taking food every third or fourth hour pleading in excuse for such conduct that they cannot do without it. The truth is, that when the stomach is disordered the exertion of digesting a single meal after its excitement and efforts have ceased is productive of sensations of languor, sinking and inquietude which ought to be calmed or counteracted by medicines and not by food, for a second meal cannot be digested in this state of the stomach. We also often tease and disorder our stomachs by fasting for too long a period ; and when we have thus brought on what I may call a discontented state of the organ, unfitting it for its office we sit to a meal and fill it to its utmost, regardless of its powers or its feelings. The rules, then, for diet may be thus summarily expressed ; We

should proportion the quantity of food to the powers of the stomach, adapt its quality to the feelings of the organ, take it at regular intervals of six or seven hours thrice during the day."

Abernethy's advice in regard to alcohol could not have proved very palatable to a generation somewhat addicted to its immoderate use. He says : " All stimulants must be regarded as medicines ; vinous liquors are of this class and being very suitable to the feelings of the stomach are in many cases very useful. The rule for taking vinous liquors in persons to whom habit has rendered them necessary may be thus briefly stated. They should not take them during their meals lest the temporary excitement they produce should induce them to take more food than the powers of the stomach are capable of digesting but afterwards they may be allowed so much of them as may be required to induce agreeable feelings ; or to express the fact more clearly, as is necessary to prevent those uncomfortable sensations which the want of them may occasion ; and, it may be added, the less they take the better."

ENTEROCYSTOMA.

By RUTH ELIZABETH MILLAR, Dunfermline ;

and GEORGE ROBERTSON,

HON. SURGEON TO THE DUNFERMLINE AND WEST OF FIFE HOSPITAL.

Enterocystomata are sufficiently rare to warrant a description of the rarest type of these peculiar and etiologically uncertain tumours. We recently operated on such a case in the Dunfermline and West of Fife Hospital, the patient being sent by one of our colleagues.

History.—J. F., a female, age 8 years, the youngest of a family of three, was a healthy child at birth and maintained good health until she reached the age of 4 years, when she began to complain of attacks of sickness accompanied by severe vomiting. Her mother states that each attack lasted twenty-four hours, had a sudden onset and an equally sudden termination, that the child was prostrated during the attacks, and that the vomit was only exceptionally bile-stained. At first the interval between attacks was two to three months, but later was reduced to one month, so that a periodicity suspiciously like that of the menses was established. Her mother actually imagined that even at this early age the little girl was suffering from a precocious development of the sexual glands. Thus she reached the age of 7 years, which was followed by such complete freedom from symptoms for a period of six months that it was thought her troubles had at last come to an end. Four months ago, however, the attacks returned with increased severity and frequency ; severe vomiting, frequently bile-stained, and preceded and accompanied by pain in the right iliac fossa and epigastrium, continued for twenty-four hours with each attack. The intervals of freedom had shortened to two weeks. Within the last month a weekly attack has occurred. Right iliac pain had become so prominent a feature that she was sent to hospital for operation, with the diagnosis of appendicitis. We, having no opportunity to observe an attack and considering the diagnosis probably correct, operated.

Operation.—Operation, as for appendicectomy, was performed on May 4, 1929. Immediately the abdominal cavity was opened an abnormality was detected. An elongated, tense, cystic tumour was found superimposed upon the cæcum, the long axes of tumour and intestine being parallel (*Fig.* 190). The sausage-shaped mass possessed a typically intestinal appearance, exhibited peristalsis, and a constriction existed near its middle. Both ends were blind ; that which pointed to the hepatic flexure was the larger and more bulbous, the other, little more than half the size, pointed downwards and slightly inwards and overlaid the vermiform appendix, which was normal. On its deep aspect, two-thirds of the tumour, measured from the smaller end, was connected by a mesentery to the true mesentery of the ileocæcal angle.
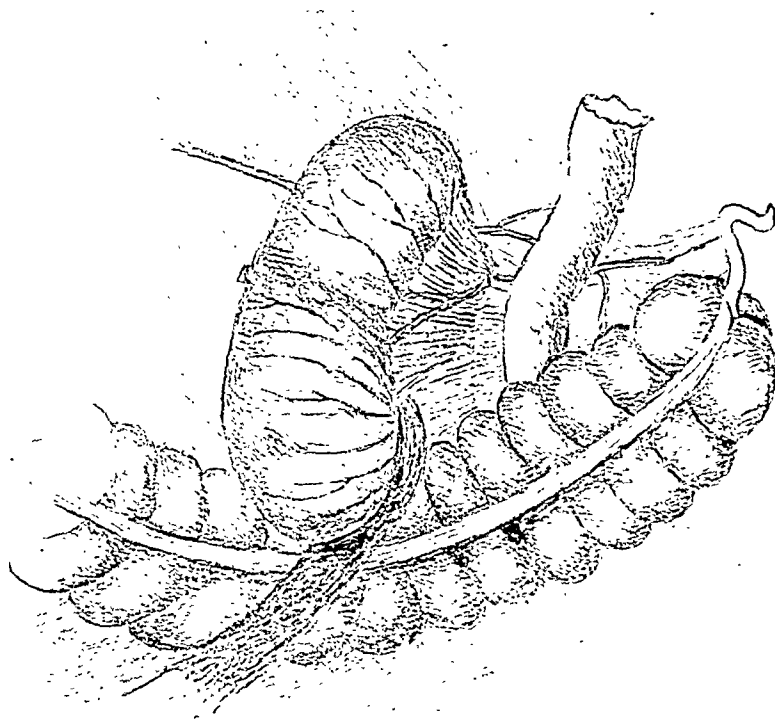
FIG. 191.—The cystoma rotated previous to removal: its attachments, mesentery and band, are well seen.
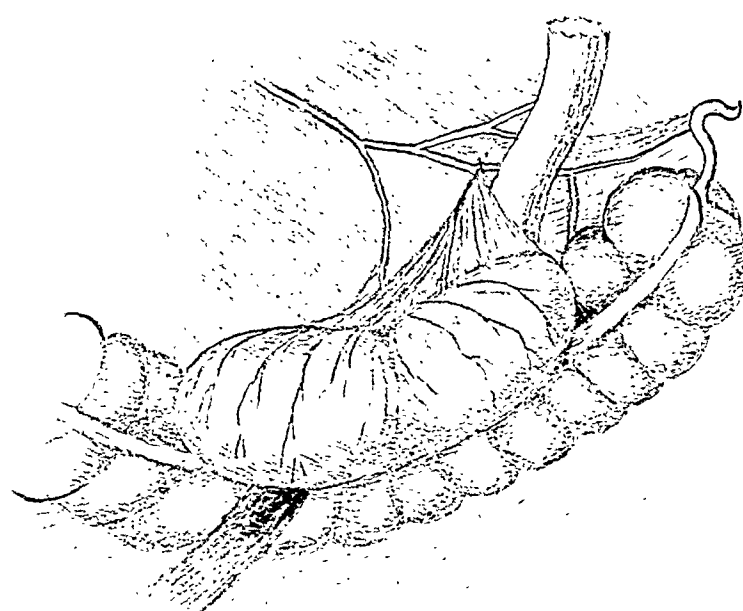
FIG. 190.—The appearances presented on opening the abdomen.

The inferior aspect of the larger bulbous end was less loosely attached by an apparently adventitious band to a pericolic membrane enclosing the ascending colon and blending on the lateral aspect of the gut with the parietal peritoneum. The loose pedicle allowed a fairly easy delivery of the cyst through the operation incision. The chief blood-supply of the tumour was directed to its mesenteric half from the ileocolic vessels, while in the adventitious band only capillaries existed, so that mass ligation was necessary only for the true mesentery of the cyst. A few tiny bleeding points were ligated over the colon when the tumour had been separated and removed. The cyst removed, no other abdominal abnormality could be seen. The appendix was resected and the wound closed.

After the patient had been removed from the operation room we inspected the cyst. As it lay on a cold specimen tray it showed active peristalsis, that wave being more pronounced which began at the small end and spread to the other, though the reverse wave was not inconsiderable. Light slapping

FIG. 192.—Cystoma after removal. (*Natural size.*)

of the cyst with a wet swab was at once followed by increased peristaltic movement, while the application of warm moist gauze pads excited the most vigorous peristalsis of all. These contractions ceased only after a lapse of over two hours, when repeated attempts, mechanical and thermal, failed to induce a response.

Figs. 190 and 191 were drawn immediately after operation. The general appearance suggests a piece of intestine, and, as will be seen from *Fig.* 192, two tiny appendices epiploicæ are situated in the sulcus on the lateral aspect of the tumour as it lay in the abdomen. Its length is 11 cm., the maximum girth at the bulbous end 10 cm., the mesenteric line of attachment is 10 cm., and the maximum length of pedicle 4 cm. Careful examination of the cyst by ourselves revealed no evidence of scar at either end of the cyst. We could therefore only hazard an opinion as to its possible origin. Two fluid ounces of an almost perfectly transparent viscous mucoid fluid constituted the content of the cyst, which was unilocular.

PATHOLOGICAL REPORT.—The Royal College of Physicians' Laboratory, Edinburgh, reported on the tumour as follows :—

Fluid Content.—Reaction, neutral ; urea, 0·05 per cent ; total protein, 0·15 per cent ; stained and unstained films show catarrhal cells and polymorphs, no food débris seen.

FIG. 193.—Shows atrophic mucous membrane (reticular epithelial cells), with fragmentary gland elements (goblet cells). Well-marked muscularis mucosæ. (× 75.)

FIG. 194.—Shows submucous layer of considerable extent. Two isolated lymphoid follicles are seen on the lumen surface. (× 7·5.)

FIG. 195.—Shows very great hypertrophy of the circular and longitudinal muscular coats. (× 7·5.)

FIG. 196.—Shows a lymph gland in the mesentery of the tumour, also blood-vessels and nerve-fibres. (× 75.)

Specimen.—This has all the appearances of a portion of intestine. It is more dilated at one end than at the other and there is some evidence of slight constriction between these two portions. At the broad dilated end there is a rim of what might have been scar tissue, but the appearance is not that of scar when cut

across. A ridge, corresponding doubtless to the mesenteric attachment, runs along the specimen in its long axis and outer aspect. Three portions were taken for microscopic examination, one from either end and one through the mesenteric attachment. Microscopically there is no evidence of cicatricial tissue at either end. The chief features are : (1) An atrophic mucous membrane almost devoid of epithelial covering ; (2) A greatly hypertrophied muscle coat.

In more detail the microscopic characters are : The mucous membrane shows a condensation of cells which has much the appearance of an epithelial covering, but which consists really of reticular epithelioid (connective-tissue) cells, forming a smooth surface layer. Here and there are gland elements of fragmentary character. In their appearance (numerous goblet cells in some cases) they suggest those of large intestine. Small isolated lymphoid follicles are present and extend right to the lumen surface. The cells of this mucous membrane are of reticulum type, connective-tissue cells, lymphoid cells, and eosinophils. A well-marked muscularis mucosæ of two layers, superficial circular and deeper longitudinal, is present (*Fig.* 193). The submucous layer of loose connective tissue, with numerous blood-vessels, is of considerable extent and is separated from the muscular layer by a very condensed fibrous tissue (*Fig.* 194). The circular and longitudinal muscular coats are markedly hypertrophied. (*Fig.* 195). In the mesentery there are well-formed blood-vessels, numerous nerve-fibres, and a small lymphatic gland (*Fig.* 196).

In our opinion the tumour undoubtedly belongs to the enterocystomata, which have been described by Roth,[1] Dittrich, Runkel, Rembach, Gfeller, Colmers, Terrier and Lecène,[2] Cautley,[3] and others. It would appear that Roth's studies were confined to enterocystomata of vitelline origin. He describes them as " congenital pouches filled with fluid whose wall possesses more or less perfectly the structure of the intestinal canal ". In enterocystomata of vitelline origin it is only that part of the omphalo-mesenteric duct attached to the intestine which persists, and, becoming cystic, may either still preserve its communication with the lumen of the gut or become completely separated from it. Most authors agree that all enterocystomata cannot be proved to be of vitelline origin, and some hold that certain non-vitelline cysts are teratoid in character. To say that a cyst is non-vitelline because it has developed on the mesenteric border of the intestine or between the leaves of the mesentery would be quite incorrect, for, according to many observers, these are frequent sites, though the antimesenteric border may be the most usual. Again, though the structure is typically that of the small intestine in most cases of vitelline cysts, it would be wrong to assign too much importance to variations in single features, e.g., the mucosa, for it must be remembered that the origin of the cyst dates back to embryonic life when the intestinal epithelium was incompletely differentiated ; thus epithelial polymorphism is easily explained. The rarest type of enterocystoma is that we instance, in which the cyst and normal intestine are connected only by a peritoneal fold or mesentery, no solid or patent intestinal pedicle existing between them. Whatever their origin, all enterocystomata would seem to have certain points in common : viz., etiologically, that they are mostly found in young females ; pathologically, that they are most commonly found in the region of the terminal ileum or in the ileocæcal angle, are unilocular, and filled with a clear, viscous, mucoid liquid. Malignant disease (spindle-celled sarcoma) has been known to invade the cyst wall, and one case is reported where it became infected by tubercle from contact with a loop of tuberculous gut.

Clinical History.—These tumours may be symptomless throughout life ; some have been accidentally discovered at autopsy. Symptoms, when present, are vague abdominal pain and recurrent attacks of vomiting. Occasionally they cause intestinal obstruction by torsion or by seriously encroaching upon the lumen of the gut (submucous type). They may, occasionally, be palpated as a rounded or elongated tumour. When they have shown malignancy they have been known to cause persistent ascites. A diagnosis is difficult. Symptoms of intestinal obstruction may fill the picture ; at other times appendicitis, acute or catarrhal, may be diagnosed. Only laparotomy can disclose the real nature of the disease.

Treatment.—In uncomplicated cases the treatment consists of extirpation, which may or may not necessitate resection of a piece of intestine. When the cyst is entirely separated from the bowel and has a mesenteric pedicle, its removal is a very simple surgical procedure, as in our case.

The case we present possesses many features common to the etiology, pathological anatomy, and clinical behaviour of those cysts which have been reported by other surgeons, but we are uncertain whether it is of vitelline origin or not.

Pain and Vomiting—Disturbed Reflexes.—We have renewed our interest *in the interpretation of the disturbed reflexes of acute abdominal diseases.* Referring back to the patient's history we find that all attacks she suffered from the age of 4 to 8 years were marked by severe vomiting, but that *only* within the last six months had abdominal pain appeared as a symptom and, becoming more severe with each succeeding attack, demanded special treatment, as on the last three or four occasions.

Pain originating in the hollow viscera is of great and abiding interest. It seems to us that, though it is generally believed that the pain of intestinal colic, appendicular colic, etc., is due to severe and prolonged contraction of the plain muscle of the viscus, confusion results in the minds of many who persistently, and with no supporting evidence at all, forsake this definite and proved cause of visceral pain just because a lesion, e.g., an ulcer, happens to be present.

In the enterocystoma under review pain preceded and accompanied the attacks only in the last six months, though *painless attacks of severe vomiting* had occurred with great regularity for the previous three and a half years. It will be noted from the microphotographs that a great hypertrophy of the muscle coat existed, while the mucous membrane showed a definite atrophy. Both these features were probably progressive. Atrophy of the mucous membrane would result in a reduced power to *secrete* and most probably to absorb ; muscular hypertrophy would *increase* peristalsis and cause pain.

We have found that a patient who possesses *what we term the 'sausage'* appendix, i.e., an appendix whose muscular coat is greatly hypertrophied and whose lumen is dilated behind a stricture near the cæcal end of the viscus, suffers much from gastric symptoms, the so-called 'appendix dyspepsia' which, when actual obstruction of the abnormal viscus threatens, amounts to actual and repeated attacks of vomiting. We have been so impressed with our constant operative findings, that if a patient suffering from an acute lesion of the appendix tells us that he or she has vomited repeatedly on the

first day of the disease, we feel confident that on opening the abdomen the 'sausage' appendix will be found. When the appendicular wall becomes gangrenous pain lessens or disappears; this is not because a dead appendix, like a dead foot, causes no pain, as Murphy used to teach; rather is it because the muscle of the appendix has lost its contractility.

In our enterocystoma progressive hypertrophy of the muscle coat had occurred over a period of four years, and thus we seek to explain the increasing severity of the attacks, which, though at first only evidenced by reflex vomiting, were at the later period painful as well. It is perhaps admissible to believe that temporary strong peristalsis of our patient's intestinal tube might be shared by the cystoma, an isolated intestinal segment whose nerve-supply was similar to and connected with that of the normal intestine. A heavy meal, a common error in a child's dietary, might not produce actual colic in the normal gut, but might easily do so in a closed segment whose cavity was distended with fluid and whose wall possessed great muscular hypertrophy. The intervals between the attacks, when no complaints of any kind were made by the young girl, are more difficult to explain than the attacks themselves. The intervals of freedom from abdominal distress that accompany catarrhal appendicitis are explained by the re-establishment of free drainage of appendicular contents into the cæcum. In our case, however, the only diminution of content that could occur would be by absorption via the blood-vessels and lymphatics of the anomalous intestinal wall. Tension of the cyst from increase of content would excite an attack (vomiting and pain) by supplying the stimulus to the hypertrophied muscular coat; relaxation of the cyst wall would act in an opposite manner. The mucous membrane of the cyst was, no doubt, though atrophied and atypical, still to some extent secretory and absorptive; but exactly what stimulated secretion on the one hand, inducing an attack, and absorption on the other, terminating one, it is, in our opinion, impossible to say. Even partial torsion of the whole cystoma is untenable as a cause of the attacks, for we found that the nature of its attachment to the colon and parietal peritoneum laterally would preclude all attempts at torsion. Moreover, the wall and contents of the cyst gave no evidence of either past or recent interference with the blood-supply.

We are indebted to Dr. Harvey, of the Royal College of Physicians Laboratory, Edinburgh, for his report on the specimen and for the microscopic slides. To Mr. Macgregor, our artist friend, we tender our thanks for the drawings.

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CONGENITAL DISLOCATION OF THE HIP: WITH SPECIAL REFERENCE TO THE ANATOMY.

(Being the Lady Jones Lecture delivered at the University of Liverpool on Feb. 28, 1929.)

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ALTHOUGH congenital dislocation of the hip is not nearly so common in this country as it is in certain parts of France and Italy, we meet it here sufficiently often to make it a subject both of interest and importance. In spite of the fact that for many years past an increasing amount of attention has been paid to this deformity by surgeons throughout the world, there is still no general agreement as to the treatment, which must necessarily vary with the age of the patient. A great deal can be found in medical literature about the anatomy of this affection, but there are details which appear to have been overlooked, and others, I venture to think, which have not received the attention they seem to deserve. This paper is a review of the subject from the anatomical aspect, and then discusses the bearing that the facts presented have on the treatment.

ANATOMY OF THE NORMAL HIP.

To turn for a moment to the normal anatomy of the hip-joint: if the neck of the adult femur is looked at from the front, there is often apparent a faint ridge, more marked above than below; this divides the surface into an inner rough and an outer smooth area, the latter being grooved. Walmsley[1] named this ridge 'the capsular ridge', and compared the groove external to it with a pulley, and called it 'the capsular groove'. In contact with this groove is the supero-lateral portion of the capsule, which is under greatest tension, he says, in full extension of the joint.

The angle formed by the axis of the head and neck with that of the shaft—the 'angle of inclination', as it is called—is about 125°, or slightly more in children, but it may vary considerably in apparently normal hips. The angle of anteversion, or antetorsion, which is the angle the axis of the neck makes with the transcondylar line, shows even greater variation in hips which display no sign of instability. Pearson[2] gives the mean figure for this angle as 15·3°, while Burghard[3] says it varies from 15° to 25°. Soutter and Bradford[4], in 154 normal femora, found the angle varied from 37° to −25°, with an average of 14·3°. Mikulicz[5] gives the average figure as 11·6°, while Durham,[6] in 200 femora, found the angle varied from 0° to 35°, with an average of 11·9°. He argued that anything up to 35°, even in a dislocated hip, might be disregarded.

Of the muscles, the only group I need mention consists of the two obturators, the gemelli, and the quadratus, which pass practically horizontally

outwards to the femur. Besides their obvious use as external rotators, it seems highly probable that they serve a useful purpose in keeping the head of the femur pressed home in its socket.

ANATOMY OF THE DISLOCATED HIP.

With these few remarks I pass to the consideration of the modifications of the normal anatomy met with in the presence of a congenital dislocation of the head of the femur. The statements I venture to make are founded on a study of 35 museum specimens, comprising 46 dislocated hips; an experience of some 50 open operations on cases of this deformity (in 26 of which the joint was opened); and a perusal of much of the extensive literature in which are found many observations on the anatomy. The scarcity of museum specimens of young subjects is to some extent compensated for by the fact that research on the living is largely confined to the young.

THE BONES.

The Os Innominatum.— We may begin with the os innominatum, since the source of all the trouble undoubtedly lies in the acetabulum. If a fœtal specimen be examined, the most striking, and often the only, feature besides the slight displacement of the head of the femur is the poor development of the upper margin of the acetabulum (*Fig.* 197). This is the primary fault, to which all the other changes are secondary. Slight laxity of the capsule

Fig. 197.—Fœtus of 5½ months. Note rounded postero-superior margin of acetabulum with extension of joint behind as well as above this. (*After Van Neck.*)

Fig. 198.　Note obliteration of acetabulum by overgrowth of ischium, which forms a tubercle on each side. ‑‑‑‑‑‑‑‑‑‑ (Musée Dupuytren 742.)
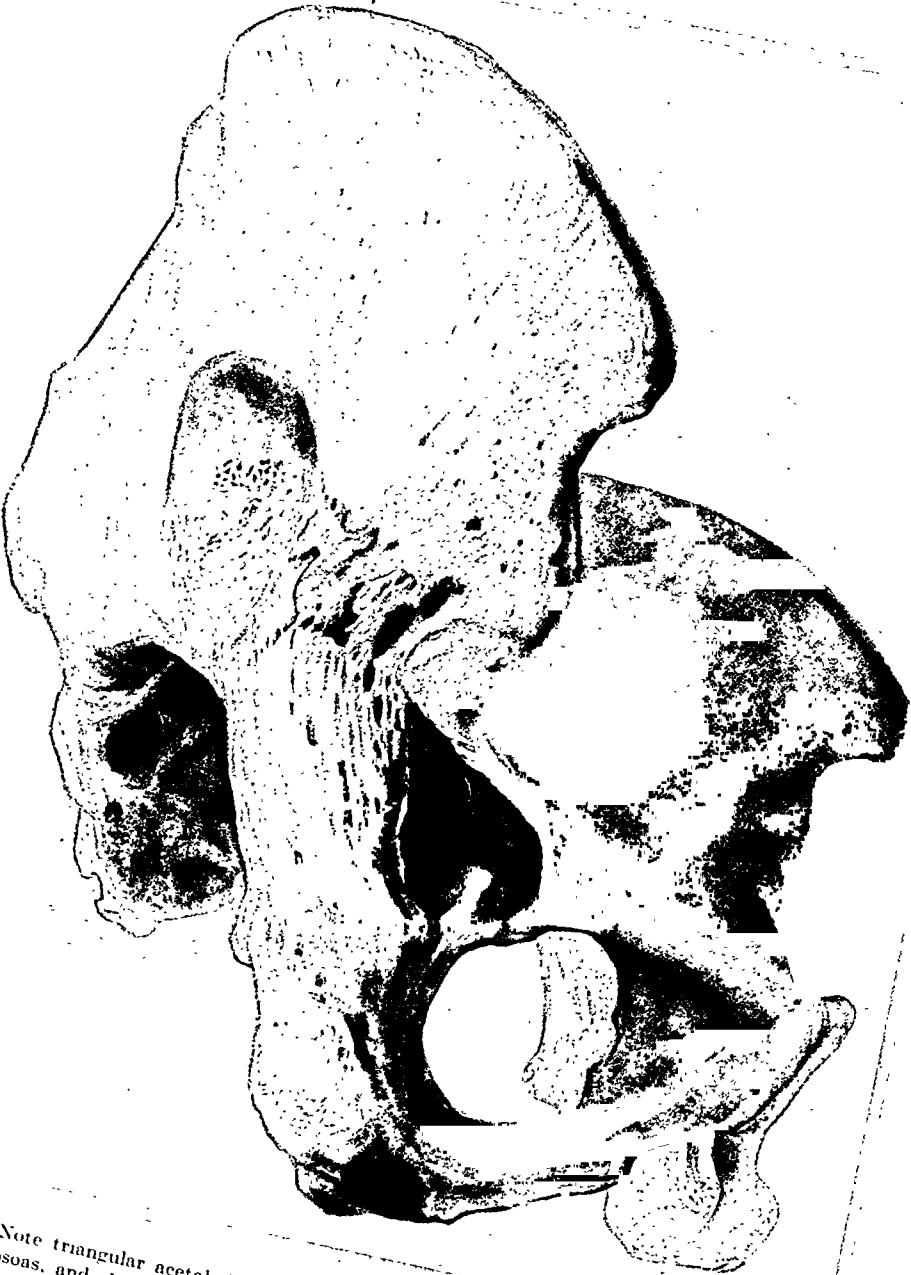
FIG. 199.—Note triangular acetabulum; well-marked retro-acetabular impression; groove for psoas, and shallow false acetabulum. (*Musée Dupuytren* 745. R. side.)

FIG. 200.—Left side of pelvis shown in *Fig.* 199. Note deep false acetabulum, the result of advanced osteo-arthritis.
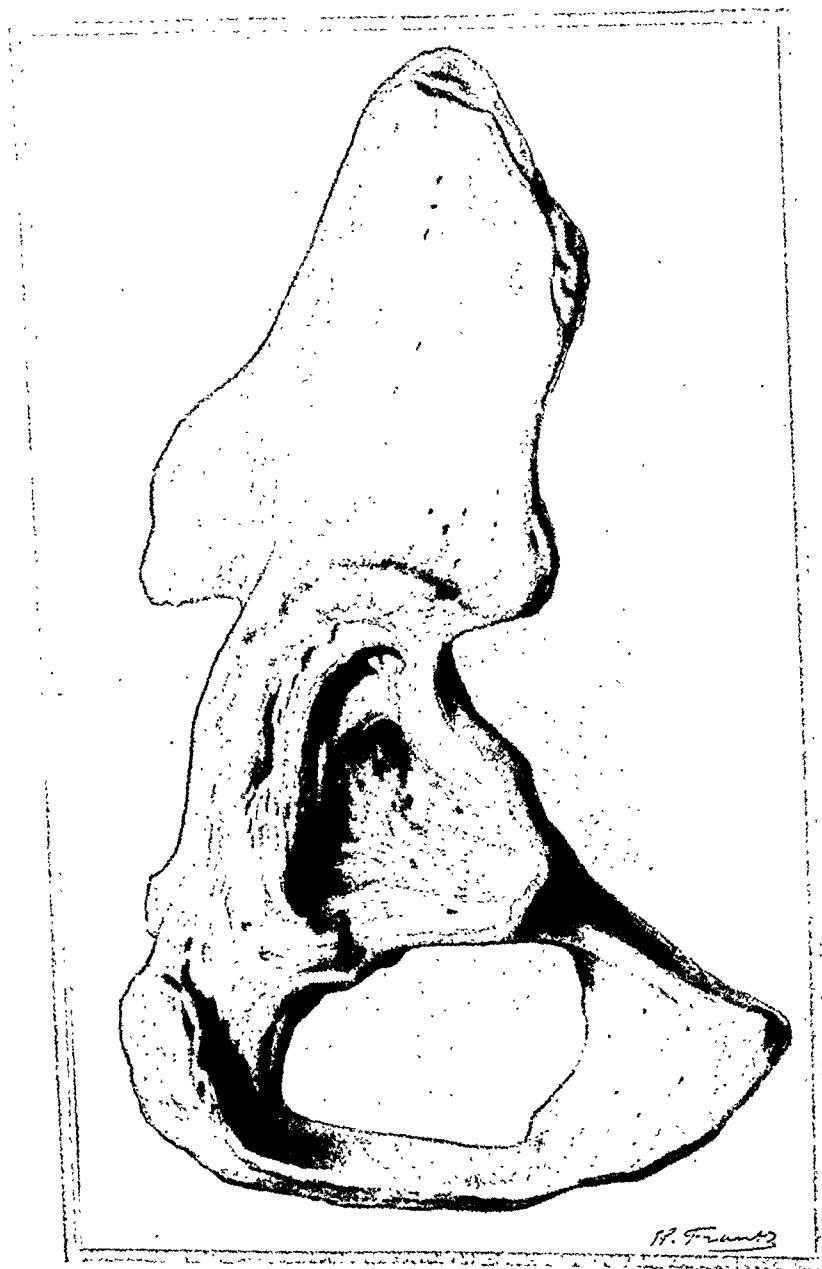
Fig. 201.—Note well-marked auricular retro-acetabular impression. Deep groove for psoas. No sign of false acetabulum. (*Musée Dupuytren* 740A.)

may be present, a point very difficult to make sure of, but even this may well be secondary. The malformation involves not only the cotyloid ligament, but also the cartilaginous margin, and even the bone—as may be clearly seen in radiograms taken within a few months of birth. Before many years have passed the acetabulum becomes triangular, with the base towards the obturator foramen and the apex pointing upwards and backwards. One specimen estimated as being about 9 years of age has a distinct suggestion of this triangulation. Bowlby[7] reported a well-marked triangular acetabulum at 13 years. This triangulation is the result of the continued growth, unchecked by the pressure of the head of the femur, of the antero-superior and the posterior boundaries of the socket. In the case of the latter the growth is excessive, in response to the unusual stresses and strains induced by the dislocation, as will be shown later. These margins of the acetabulum are usually straight and sharp, and not uncommonly undercut. In the vast majority of the dry specimens examined the cavity is surprisingly deep, even up to the age of 60 years, but the floor is more or less flat. The edges in some cases are lipped, especially the posterior, which may overhang the cavity to a marked degree. The transverse ligament may be ossified. In the fresh specimens the cavity is to a large extent filled by cartilage and a fibro-fatty overgrowth of the Haversian gland. Hoffa[8] said there was always cartilage in the floor, though this might be covered with fibrous tissue. In one remarkable specimen, unfortunately lacking the femora, in the Dupuytren Museum in Paris, both acetabula are practically filled by an overgrowth of the ischium, which forms a nodule on each side (*Fig.* 198). The obturator foramen is more triangular than normal; the pubic angle is increased; the ilium is shorter and broader than normal; and the anterior border is prolonged in the vertical direction and displays a wavy outline. The anterior inferior spine is twisted to conform to this outline, being convex inwards above and outwards below, the latter corresponding to a well-marked groove for the ilio-psoas tendon.

On the dorsum ilii, in adolescents and adults, there is usually something to be seen in the way of a false acetabulum. Even in adults this may be nothing more than a shallow pond, more or less circular, with but a faint rounded margin. As a rule this pond is considerably larger than the femoral head, which rests in or against it, and this disproportion in size suggests there must be considerable mobility of the femur, in an antero-posterior as well as a vertical direction. It may show one or more raised flat-topped bosses, with smooth, eburnated surfaces (*see Fig.* 208). In some cases the edges are well developed, while occasionally a deep hemispherical cup with a polished eburnated floor is seen. Such a well-formed false joint is clearly the result of osteo-arthritis, and is associated with similar changes in the femur. In a bilateral case these arthritic changes may be present to a marked degree on one side while they are entirely absent on the other (*Figs.* 199, 200). The false acetabulum may be represented by a large facet, slightly hollowed and raised above the level of the surrounding bone, and with a polished surface and sharp edges (*see Fig.* 202). In situation it may be high or low, more anterior, or far back close to the great sciatic notch. In some it is difficult to determine where the head rested, unless against an area of thickened bone just above and behind the acetabulum; this may or may

not be continuous with the rough impression on the ischium shortly to be described.

Of 38 hips in which a visible false acetabulum was expected, it was a mere shallow hollow with little or no margin in nearly half (17). In 9 specimens there was no sign of a false joint, while in 9 a well-marked arthritic socket, with lipped margins and an eburnated floor, was present. In one case the ilium showed facets but no hollow.
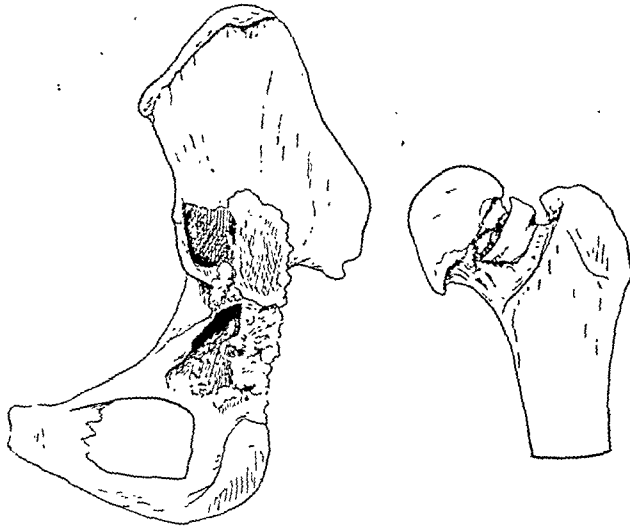
FIG. 202.—Note false acetabulum, a slightly hollow, raised facet. Retro-acetabular impression shows polished, pitted surface with sharp margins, encroaching somewhat on acetabulum. Deep hollow between inferior iliac spine and false acetabulum. Femur shows raised facet on neck. Slight lipping of head. (*Musée Dupuytren* 749B.)
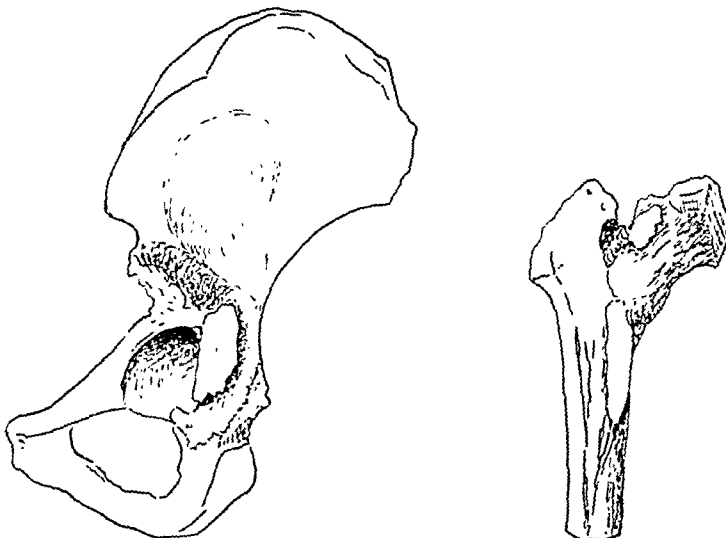
FIG. 203.—Note retro-acetabular facet, slightly overlapping acetabulum. False acetabulum shallow, but extensive, with deep groove below it. Femur shows flattening of head, two facets on neck, and facet replacing lesser trochanter. (*Musée Dupuytren* 757P.)

FIG. 204.—Note well-marked auricular retro-acetabular impression. No
sign of false acetabulum. (*Musée Dupuytren* 747F.)

The ischium shows perhaps the most remarkable changes of any of the bones, yet it has received but scant attention from surgeons. It is usually said that the tuber ischii is everted, but this is hardly an accurate description of the changes found. On looking at the bone that lies behind the acetabulum, formed by the ischium below and ilium above, in most adult cases we find the normal smooth, slightly convex surface profoundly changed. It may be simply roughened, with many pits, ridges, and nodules ; it may be raised into a definite ridge with a similar roughened surface ; while it may present a raised articular facet with a smooth polished surface of varying size (*Figs*. 201, 202, 203).

In 8 of the 36 specimens in which this area was exposed there was nothing very remarkable about the bone. In all the remaining 28, however, notable changes had taken place. In 8 what may be termed the retro-acetabular impression showed an unusually roughened surface ; in 9 a definite broad ridge was seen ; while in 8—with the possible addition of a ninth—there was a facet.

As will be seen later, the joint cavity overlaps this surface, and this extension might account for the striking smoothness noticed in a few specimens (3). The excessive roughness and the thickening of the bone are due, I suggest, to the excessive strain that has to be borne by the hypertrophied ischio-capsular ligament, which is here attached. The facet, when present, is due to pressure and friction against the lesser trochanter, which shows similar changes. The 'impression', whether only roughened or ridged as well, may extend above and forwards over the top of the joint to form an auricular shaped surface (*Fig*. 204). When this auricular impression is seen it seems possible—even probable—that the head of the femur had rested opposite the upper part of it, since no sign of a false acetabulum is found higher up. When facets are present on the pelvis and femora these have not necessarily been in direct contact—in fact, in most cases, and perhaps in all, the capsule has intervened between the bones. As I hope to show presently, the postero-inferior portion of the capsule is not attached close to the acetabular margin, but some distance farther back—in some even as far back as the posterior margin of the retro-acetabular impression. The ischial facets are in front of the capsular attachment and are therefore within the joint cavity. The facets are usually single, but in the Royal College of Surgeons Museum is a specimen showing three. In size they may be as small as a sixpence, while the largest seen measured $2\frac{1}{4}$ by $1\frac{1}{2}$ in. In this case the facet has spread forwards over most of the old acetabulum (*see Fig*. 210).

The Femur.—Even in young children the head is smaller than normal, though relatively large compared with the acetabulum, while the ossific centre is late in its appearance, and smaller than that of the normal femur. Before long the head becomes flattened by pressure against the ilium on its inner and posterior aspect, while less commonly it is also flattened in front and on top. The head then suggests a wedge rather than a cone, the edge of the wedge lying in a plane which runs downwards and forwards (*Fig*. 205). A conical head may be seen, but is rather less common. Bowlby[9] described such a head, the apex of the cone corresponding to the stump of the

ligamentum teres, which had disappeared. In some cases, and particularly in adults, much greater changes are seen : these are of two kinds—namely, erosion and lipping—either of which may predominate. The amount of erosion varies from a slight pitting of the cartilage surface to complete disappearance of the head. After much forcible manipulation pitting has been met with in a case only 4 years of age. Lipping may be seen at the lower margin only of a conical or otherwise misshapen head, while it may produce a typical mushroomed head with little or no erosion. When combined with erosion and
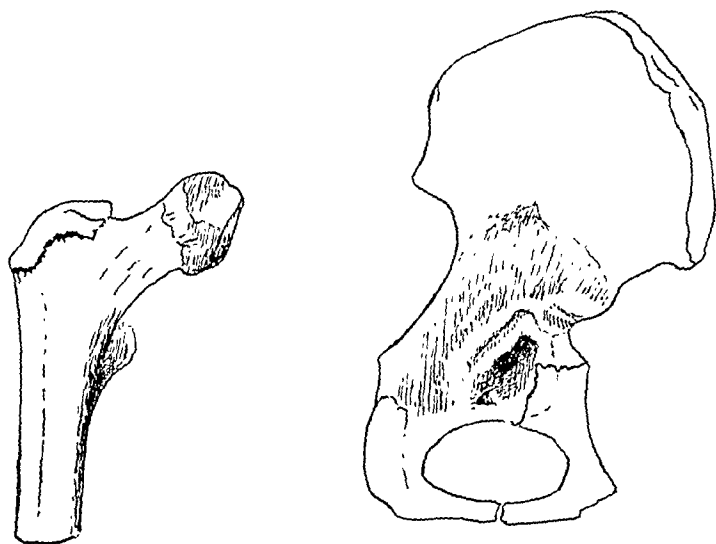
FIG. 205.—Pelvis shows very shallow acetabulum, with rounded margin, and above and behind it an extensive auricular impression. Femur shows a well-marked wedge-shaped head. (*Musée Dupuytren* 739A.)

eburnation it produced the appearances characteristic of advanced osteoarthritis. In adults one is sometimes surprised by the rounded contour of the head as seen in a radiogram, though it is common enough in such cases to see the head reduced to an irregular knob much smaller than the normal (*Fig.* 206). Bradford and others[10] found flattening of the head present in all cases of 10 years and upwards. Gill,[11] in the light of his operative experience, says the cartilage is loosely attached to the bone and easily detached by force even against the acetabular margin.

As to the museum specimens: in most of the youngest, as well as in 2 of the adults, the head was of fairly good shape; 5 showed wedging as against 4 with a conical head; in one the head was flat above and inside: 10 showed marked irregularity in shape and lipping; 5 showed advanced erosion; in over half (17) there were definite signs of arthritis of some kind.

In two femora with conical heads was seen a curious circular groove running at right angles to the axis of the cone. and presumably due to pressure by a fold or ridge in the capsule (*Fig.* 207).

FIG. 206.—Acetabulum prolonged upwards as a groove surrounded by roughened bone, shows roughness typical of ligamentous strain. Transverse ligament ossified. Retro-acetabular impression. (*Mus. Liverpool Univ.*)

The neck of the femur may be normal in length, but is often short and slender. The older the patient the less likely is the neck to be normal, not only as to its length, but in other ways. Coxa valga, often more apparent than real in a radiogram, may be present, but coxa vara is much more frequently met with, though not so commonly before as after reduction. Of 32 femora of all ages examined regarding this point, only 9 showed definite coxa vara; the worst of these showed a right-angle deformity.

Fig. 207.—Note circular groove on femoral heads. (*Musée Dupuytren* 741A and 748.)

As to antetorsion, stress has been laid on this by most writers, many attributing their failure to maintain reduction in some cases to the presence of this deformity. Farrell, von Larkum, and Smith,[12] by taking radiograms in the neutral and the fully inverted positions, estimated the antetorsion in 336 cases. In nearly half the angle was over 20°; of these about half gave an angle of 20° to 50°, while in the remainder, i.e., nearly a quarter of the whole, the angle was over 50°. While admitting the great difficulty of accurate estimation, they conclude that antetorsion is a factor of considerable importance. On the other hand, in 1000 cases, Froelich[13] found an extreme degree of antetorsion in only 1 per cent. Whitman[14] suggests that an angle of 35° is normal at birth, and that this is gradually reduced, by tension of the capsule, to 15° to 10°. If the hip is dislocated, this reduction does not take place. My own impression is that while an angle above the normal is extremely common—almost the rule—extreme degrees of antetorsion rendering permanent reduction an impossibility are rare. In one remarkable case met with at the age of 9, with 2½ in. of shortening, *retro*torsion was present, the head lying behind the trochanter. This patient only commenced to walk in her fifth year. The accurate estimation of the angle of antetorsion in the living subject is a matter of considerable difficulty. I am greatly indebted to my friends, Drs. Shires and Graham Hodgson, for the trouble they have taken to help me in this matter.

The most promising method for research seems to be that suggested by Stewart and Karshner,[15] though this has the disadvantage of depending on the use of the screen, in a darkened room. The patient lies prone, with the knee on the affected side flexed to a right angle, and the tibia vertical. The foot is carried over towards the sound side. i.e.. the femur is externally rotated until the head, neck. and shaft appear to be in a line. By means of a graduated arc and pointer this angle is measured; the result subtracted from 90 gives the angle of antetorsion. They say that the margin of error is not more than 5°.

In the 26 museum specimens in which this could be noted. only the upper few inches of the femur being available in most. the angle of antetorsion was estimated as varying between 0° (3 cases) and 75° (1 case). In no fewer than 11 the angle was about 45°. while the average worked out at 30·6°—not a very high angle, be it noted.

A feature of considerable interest is the finding of smooth polished facets on the neck of the femur. These I found on 7 femora, in 2 of which two separate facets were seen, one in front and the other behind, close to the

FIG. 208.—Note retro-acetabular facet overlapping acetabulum. Raised facets in floor of false acetabulum. Femur shows conical head, facet on neck, and pronounced tubercle on anterior inter-trochanteric line. (*Musée Dupuytren* 749C.)
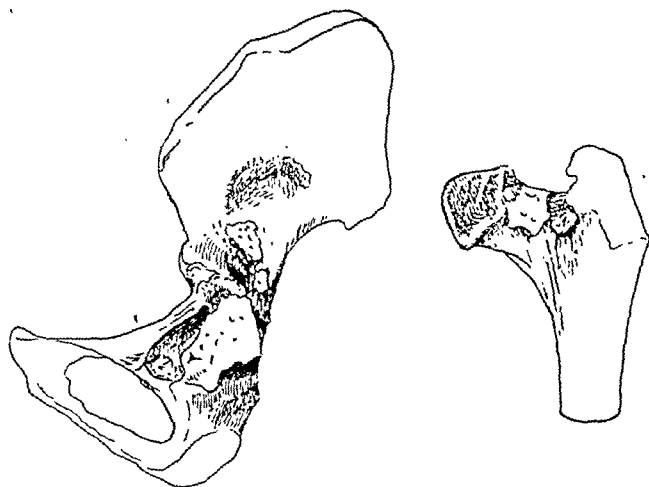
upper surface of the neck. In the other 5 only one facet was present, and this was situated high up on the anterior surface; in 3 of these it extended on to the superior surface. The facets are not extensions from the head, but are quite separate from it (*see Figs.* 202, 203, 208). They were raised above
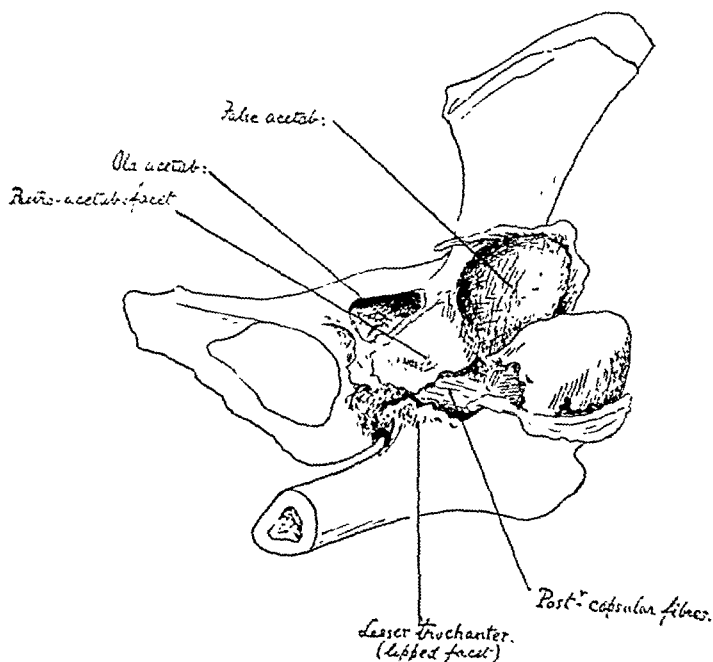
FIG. 209.—Note large retro - acetabular facet with ischio - capsular band attached *behind* it. Acetabulum shows sharp margins and ossified transverse ligament. False acetabulum and head of femur show marked osteo - arthritic changes. Lesser trochanter shows lipped facet. (*Musée Dupuytren* 746.)

the level of the surrounding bone—in some cases markedly so—and from their shape and grooved surface unquestionably took the strain of the capsular sling. In other specimens, devoid of facets, the grooving of the neck above was at least suggestive of unusual pressure.

In some femora (7 in this series) the tubercle near the upper end of the anterior intertrochanteric line, for the attachment of the iliotrochanteric band, was particularly well developed (*Fig.* 208); in others it was entirely absent.

While in children the lesser trochanter is normal, in adults it may show most striking changes. It may be entirely absent, be represented by a flat elongated area with a faint raised margin, or finally it may be well formed but have at its apex a flat facet. · This facet may have a smooth eburnated surface, with an overhanging lipped margin, and varies considerably in size. In those showing the largest facets, the process is much elongated in the vertical direction (*see Figs.* 203, 209, 210).

Our findings in the museum specimens were as follows : normal in 12 ; facet present in 8, possibly 9 ; entirely absent in 1 ; very prominent and lipped without definite facet in 2 ; and situated abnormally low in 1. Six specimens were too young to show any change.

FIG. 210.—Note extremely extensive facets behind acetabulum and on lesser trochanter, and the presence of capsule behind the facet on ischium. False acetabulum and femur show marked osteo-arthritic changes. A portion of capsule has been left arching over neck of femur (capsular sling). (*Musée Dupuytren* 753C.)
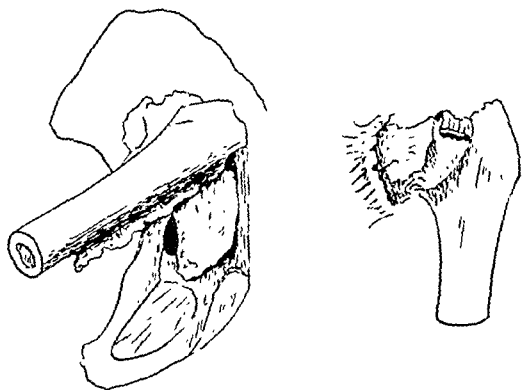
As a rule if there is a facet behind the acetabulum, there is a corresponding facet on the lesser trochanter, but in one bilateral case in the Dupuytren Museum the femora show facets while there are only well-marked ridges, without facets, on the pelvis.

X-ray Evidence.—After childhood the development of the retro-acetabular ridge and the presence of facets at this spot and on the lesser trochanter can often be seen in the radiograms of untreated cases, and also in many where relapse, partial or complete, has followed reduction (*Fig.* 211). At first it was thought these facets would only be found in the presence of adduction deformity, but this proves to be incorrect, for recently a case was seen with a full range of abduction, and yet well-marked facets were shown in the radiogram. As a sign of instability after apparently successful treatment, thickening of the ischium is of considerable value, but cannot be relied on absolutely. Though to be seen in most cases showing imperfect acetabula, it is occasionally absent when the joint is obviously unstable or even subluxated. Two other anatomical peculiarities have been revealed by X-ray examination. The first is a loose fragment of bone, not unlike a sesamoid, at the back part of the tuber ischii. This has been met with three times : the origin of this fragment is doubtful, and may not be the same in each case

(*Figs.* 211, 212). The second, seen in a few cases, is a prominent tubercle situated a little below the level of the upper lip of the acetabulum (*Fig.* 213). This seems to be an outgrowth of the posterior margin of the socket.

FIG. 211.—Radiogram of left hip of woman of 26 (unsuccessful reduction at age of 5). Note facets on pelvis and lesser trochanter. Ischial tuberosity shows loose bony fragment.
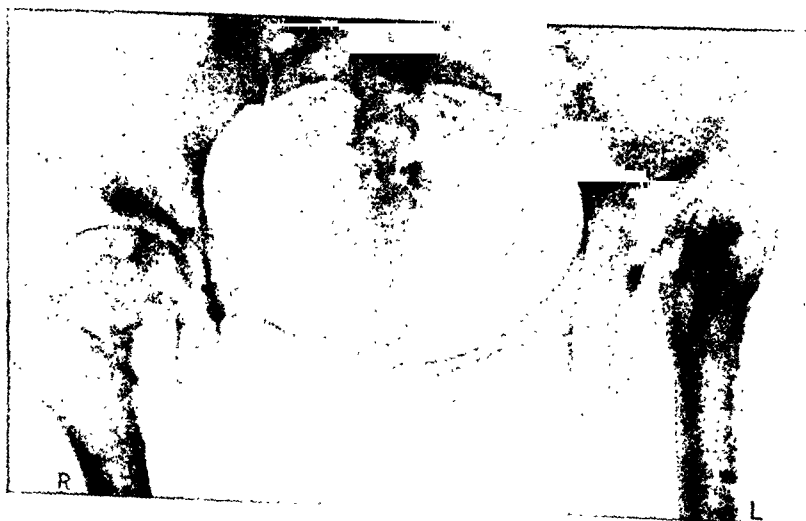
FIG. 212.—Radiogram of bilateral dislocation. Woman of 21 years. Reduction at age of 5. Note ischial projection with large loose fragment on left.

The bones of the leg may be either shorter or longer than those of the opposite limb. As much as half an inch of shortening has been noted between the tip of the trochanter and the external malleolus before reduction,

while the foot is frequently smaller than its fellow. On the other hand the shortening, as measured in the usual way, may be less than the radiogram would lead one to expect. A boy of 10 with a subluxation of the hip showed the affected leg nearly half an inch longer than the other. After successful reduction we have found the limb longer than the other in many cases, the greatest difference noted being three-quarters of an inch ten years later.

FIG. 213.—Bilateral dislocation, girl of 12 years, untreated. Note tubercle on each side just below level of upper acetabular margin.

The Capsule.—The general arrangement of the capsule has been well known for many years. As the head migrates upwards it carries in front of it a dome of the capsule which blends with the periosteum above and behind the acetabulum. Where this fusion occurs in the floor of the false acetabulum, the two are transformed into fibrocartilage. In response to the abnormal strain to which it is subjected, the capsule, though lax and thin at first, becomes thickened, the thickness attained varying considerably in the different portions of the capsule and in different cases. It may be as much as a third of an inch in thickness in a child of 13 years. It is generally said to be thickened in front, the part, be it noted, where it is almost invariably incised by the surgeon. The presence of a well-marked tubercle on the front of the femur suggests great strength in the iliotrochanteric band. It is particularly strong below, where it is often divided by the surgeon to enlarge the isthmus, and where it is in close relation to the psoas tendon. Bradford[16] noted the strong bands passing to the lower part of the neck and the region of the lesser trochanter. The ischiocapsular band behind is always thickened, and is, I believe, of special importance. Shattock[17] described it as 'specially strong', while Bennett,[18] in one case, found the posterior capsule cut like fibrocartilage. As already stated, this band is attached, not close to the posterior margin of the acetabulum, but some distance behind it, and rather

FIG. 214.—Capsular sling has been left in place. Note capsular isthmus adjacent to femoral neck and drawn well away from pelvis. (Musée Dupuytren 749.)

obliquely, and when a retro-acetabular facet is present the attachment is along its posterior margin (*see Fig.* 209). These ischio-capsular fibres, much increased in numbers, pass upwards to arch over the neck of the femur and blend with the strong fibres in front that are attached to the anterior margin of the acetabulum and transverse ligament. In this way is formed a powerful sling which passes over the neck as over a pulley, and prevents further upward displacement of the femur (*see Figs.* 210, 214, 220). Whether plaques of bone or cartilage are ever formed in this capsular sling to correspond to the facets noted on the femur we have been unable to discover. Though the capsule lying over the neck is always thickened, and that over the head generally so, this is not invariably the case. In a young woman operated upon at 24 years, the capsule hardly existed over the head, where the reflected head of the rectus blended with it.

The ligamentum teres is usually present in young children, and frequently absent in the older cases. Increased age, greater displacement of the femur, and previous manipulative treatment are three factors that contribute to its disappearance. Hoffa[19] found it absent in 27 per cent of 200 cases, while Galloway[20] found it surprisingly large in cases not previously manipulated, and usually absent after this method of treatment had been tried. In the majority of cases the ligamentum teres is of no importance whatsoever, but occasionally it is of sufficient size to interfere materially with satisfactory reduction. In a child of only $2\frac{1}{4}$ years it formed a slab $\frac{5}{8}$ in. wide and $\frac{1}{4}$ in. thick, and this interfered with stable reduction.

The hour-glass shape of the joint cavity is well known and needs no special description. Hoffa[21] was the first to note the importance of the psoas tendon in accentuating the so-called isthmus between the true and false joints. It is sometimes forgotten that a well-marked isthmus can only be present when the head is completely dislocated, and must therefore be rare in the younger children. Only once have I seen a well-marked isthmus under three years of age.

Now the cavity always extends to some degree backwards over the retro-acetabular impression. In the fœtus this is easily explained by the size of the head from before back, its undue mobility, and the fact that as yet the displacement is slight. But why should this arrangement persist into adult life, as it certainly does in some cases, if not in all? There may be quite a definite sharp fold of synovial membrane, placed vertically and standing up into the cavity between the acetabulum proper and the retro-acetabular smooth area (*see Fig.* 217). This fold corresponds in position to the rounded posterior margin of the acetabulum in young children. It was seen in some of the museum specimens, but only once during an operation, and then, curiously enough, in a child of only 20 months whose hip was opened for
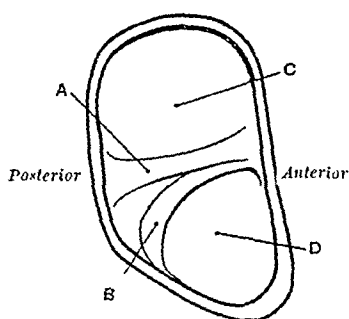
Fig. 215.—Diagram of arrangement of acetabulum on right side of bilateral case, age 4 years, to show capsular fold which descends in front of head during attempted reduction.

A, Fold of capsule ; B, Cartilaginous margin of acetabulum ; C, False acetabulum ; D, Acetabulum.

persistent relapse after reduction and fixation.   On the posterior wall of the joint in this case was seen a vertical white band.   But there is another fold which I believe has never been described, and which was first noted in a bilateral case, the patient being 4 years old.   This fold, as can be seen in the diagram (*Fig.* 215), lies more or less horizontally, but is inclined slightly downwards as well as backwards, and is situated just above the position of the upper acetabular margin.   It may be pale and yellow in colour, or red if the joint is inflamed.   It is soft and not cartilaginous, and is, in fact, a fold of the synovial membrane and capsule just above the acetabulum. When weight is borne on the leg the capsule and synovial membrane are put on the stretch above, and the fold disappears, only to reappear as the tension is relieved.   When, during attempts at reduction, the head is forced down
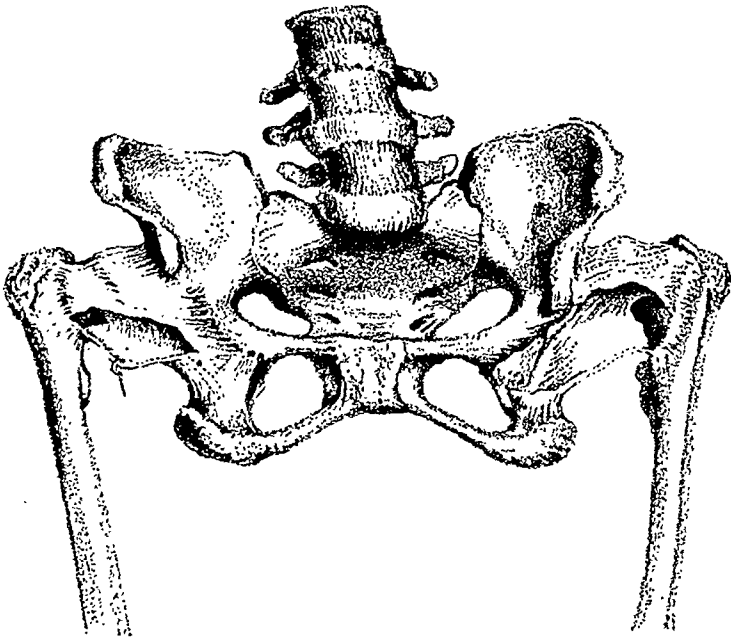
FIG. 216.—Illustration in Carnochan's book.   Bilateral dislocation showing isthmus close to femur and bounded on inner side by fold stretching out from pelvis.

towards the socket, this fold is piled up on the acetabular margin and increases the difficulty of forcing the head over it, a difficulty that might be lessened by lifting or pushing the head towards the socket as opposed to levering it in. Z. B. Adams[22] mentions a band seen deep in the socket at the back, which he thinks was " possibly a thickened cotyloid ligament folded in before the head at the first reduction ".   It is possible that he is referring to a fold similar to that described above.   Unfortunately in comparatively few museum specimens is much of the capsule present, and even in these it is usually dried, but in a few may be seen a fold standing out boldly, and presenting a crescentic outer margin which bounds the isthmus on its inner side (*Figs.* 214, 216, 217).   In these specimens, in which it is admitted the femur has been drawn somewhat away from the pelvis, the isthmus lies close to the femur, and

not, as might have been expected, close to the ilium.   One of Carnochan's[23]
illustrations (*Fig.* 216), the bones of which specimen are preserved in the Museum of the Royal College of Surgeons, shows this condition on both sides. It is suggested that this fold with the crescentic margin is an accentuation of that observed in childhood. The cavity of the joint may be said, therefore, to consist of three portions, one corresponding to the old acetabulum, another over the anterior and upper part of the retro-acetabular bone and separated from the first by a vertical fold, and a third, above, corresponding to and enclosing the displaced head of the femur (*Figs.* 217, 218). During manipulative reduction the head of the femur traverses the second or retro-acetabular compartment, on its way from the third to the first. If the isthmus is very
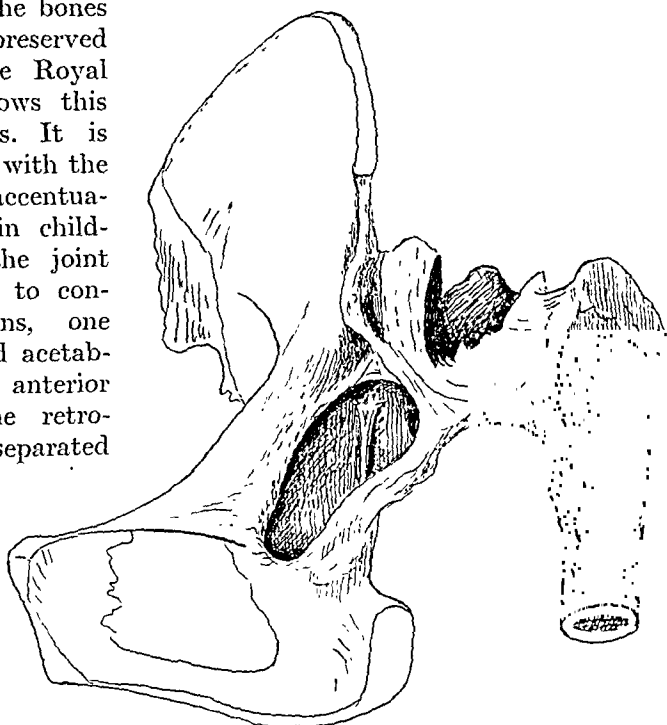
FIG. 217.—Dry specimen with windows cut in capsule. Note vertical fold between true acetabulum and retro-acetabular surface, and, above and outside this, capsular isthmus. (*Musée Dupuytren* 753.)
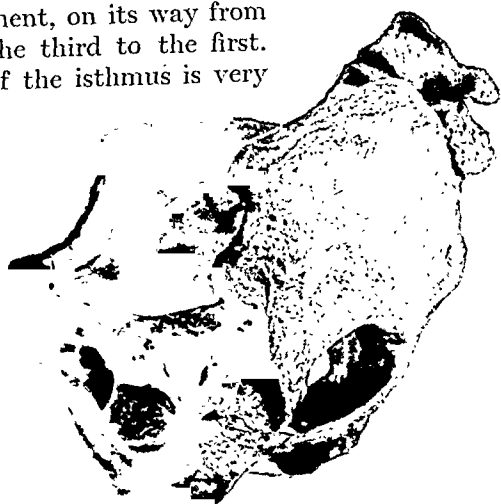
FIG. 218.—Dry specimen showing definite ridge (vertical in photograph) between acetabulum and retro-acetabular surfaces below and false acetabulum above. (*King's College Hospital Museum.*)

small, the highest compartment may be almost shut off from the other two. One specimen in the Dupuytren Museum, collected by Broca in 1848, shows the joint cavity completely divided into two.

THE MUSCLES.

The muscles are of interest and importance.

The Adductors. — These are always shorter than normal. Except in the youngest children they offer resistance to complete reduction. and in all cases they have to be stretched or ruptured before a stable position for the reduced hip can be obtained.

The Rectus Femoris.—The direct head of the rectus, in most cases, runs a straight course in front of the capsule, the whole muscle being shortened. But when the dislocation is more directly upwards, this tendon arches forwards over the capsule, and obviously assists in the stabilization of the head. It probably serves this purpose after 'anterior transposition', and when a marginal displacement follows reduction. A bursa may be present between the capsule and tendon. The reflected head in most cases is displaced from its normal attachment to the bone by the dome of the capsule, over which it arches backwards and to which it is attached. Occasionally it retains a portion of its bony origin, and still more rarely it may be found arising from the ilium high up above the false acetabulum, or even in front of this.

The hamstrings are short but of little importance, since they are easily relaxed by flexion of the knee during reduction, and can be stretched without difficulty later. The sciatic nerve is short, but can be relaxed like the hamstrings, and should not be in danger even when the shortening is considerable, if the knee and hip are kept flexed during reduction and the former is not extended too forcibly afterwards. Damage to this nerve has occurred during reduction as a result, I think, of bruising by a wedge or other fulcrum, rather than by stretching. I am convinced this was so in the solitary instance in which I produced a temporary paralysis of this nerve.

The Ilio-psoas.—This is important. Instead of the tendon, which is formed unusually high, passing downwards with a slight inclination backwards, it passes very decidedly backwards and outwards, in close contact with the capsule in the region of the isthmus. When the femur is much displaced, the pelvis tilted, and the lordosis marked, this tendon takes a practically horizontal course after leaving the pelvis. The strain put upon it is shown by the deep groove seen in every adult specimen below the anterior inferior spine. Jackson Clarke[24] says the tendon may be cartilaginous where it traverses this groove. The muscle and tendon unquestionably act as a sling to support the pelvis on the femur, while Carnochan[25] and Tubby[26] both suggest the pull of the psoas is responsible for the lordosis. Possibly this is correct, but the shifting backwards of the point of support must be regarded as of paramount importance in this respect. While Bradford and Lovett[27] describe the ilio-psoas as short, Lorenz[28] says it is long. We are inclined to agree with the former, and to regard the division of this tendon, as suggested by Burghard,[29] as an important item in the technique of open reduction.

The Glutei.—These are said to be unaltered in length, presumably because the trochanter is displaced outwards as well as up. In all cases with much displacement the gluteus medius, particularly the fibres which arise nearest the crest, must be shortened, but in the younger children there can be little change in these gluteal muscles, or we should never obtain reduction with such ease and certainly never retain it with the trochanter lying at a lower level than the head, which is the state of affairs invariably seen in radiograms with the limb in the Lorenz position. The gluteus minimus is in close apposition to the capsule, into which it is partly inserted, and from which it is separated with some difficulty. This muscle stabilizes the head by holding it against the ilium and by strengthening the dome of the capsule. It

is not a strong muscle, however, since its normal attachment has been usurped to a large extent by the dome of the capsule.

The Horizontal Group of Muscles.—These muscles, i.e., the obturators, gemelli, and quadratus, are lengthened and the direction of their fibres is altered. They no longer run horizontally, but pass upwards and backwards to reach the trochanter; they serve a useful purpose as slings for the pelvis (*Fig.* 219). Both the obturators would seem to be particularly useful in this way, the external because even in the normal hip its direction is slightly upwards, and the internal because of the pulley round which it turns as it leaves the pelvis. These muscles assist in keeping the femoral head home in the false acetabulum. After reduction no doubt they are slack, but, so long as the limb is in the right-angle position, their place is taken in this respect by the adductors and hamstrings. The desirability of restoring the short muscles to a taut and vigorous condition before the leg is allowed to return to the vertical position, is an argument in favour of encouraging
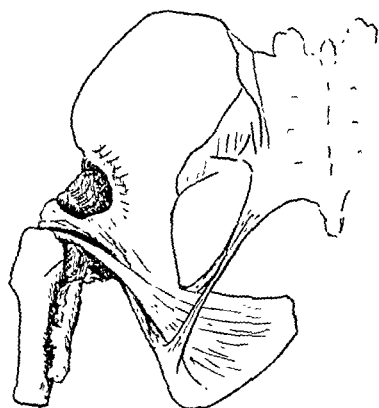
Fig. 219.—Same as *Fig.* 210, from behind, to show obturator internus muscle and large facet on lesser trochanter.
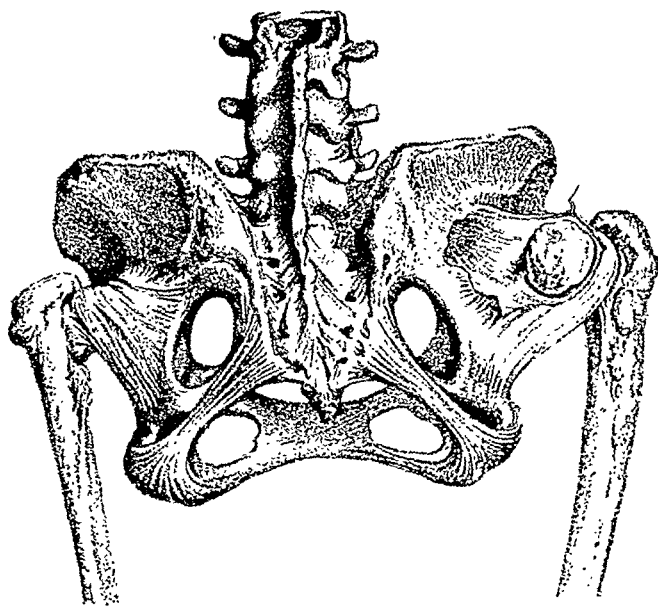
Fig. 220.—Posterior view of *Fig.* 216. Note capsular sling on each side.

walking during the period of plaster fixation, and of not including the knee in the cast.

Having considered the anatomy in some detail, it should now be possible

to form an opinion as to the method of suspension of the pelvis on the femur when the latter is dislocated. To begin with, it seems clear that, except in the ultra-arthritic case with gross lipping of the false joint, the bones have little or nothing to do with it. The work appears to be shared by the capsule and the muscles, as our knowledge of anatomy would lead us to expect. The capsular strain is taken by the thickened bands passing from pelvis to femur in front and below, but particularly by the *capsular sling* arching over the neck (*Fig.* 220). The muscles which assist the capsule and prevent further stretching of this sling are the ilio-psoas in front and the obturator group behind, while the gluteus minimus gives such help as it can.

THE LIMP.

Why does a patient with a congenital hip walk in the characteristic manner ? Why must the body weight be thrown towards the affected hip by a cast of the shoulders ? Obviously because the abduction power at the hip-joint is diminished. But why is this diminished ? Four possible explanations strike one at once : (1) The instability of the fulcrum ; (2) Deficient power of the abductors ; (3) Diminished leverage for these muscles ; and (4) Shortening.

1. **The Instability of the Fulcrum.**—It must be remembered that the femur, though greatly displaced, is prevented from riding up indefinitely on the dorsum ilii. After a variable number of years, twelve or thirteen according to Simpson,[30] it ceases to migrate, and long before adult age is reached its progress is stayed by the capsule and muscles, so it is difficult to believe that this is the sole or main factor.

2. **Deficient Power of the Abductors.**—The abductor muscles, it should be remembered, have developed with the femur displaced, and have not been relaxed by any rapid migration of the femur as occurs in a pathological dislocation. The glutei, however, are diminished in strength because the area from which they can arise from the ilium is reduced by the presence of the displaced capsule. We have to admit, therefore, that these abductor muscles are weaker than normal, but that they may rapidly become equal to their task is proved by the perfect gait assumed a few months, even a few weeks, after removal of the plaster cast when a successful permanent reduction has been accomplished.

3. **Diminished Leverage for the Abductors.**—As to diminished leverage, there are three levers the lengths of which have to be considered. These levers are represented diagrammatically in *Fig.* 221, a plan slightly modified from that suggested by Girdlestone[31] for pathological dislocation.

But the abductor muscles can be considered from another point of view. We can take it, I think, that the result of the combined effort of the abductor muscles in supporting the pelvis on the normally articulated femur acts in the transverse vertical plane of the body. The fact that the head normally lies in a plane anterior to that of the trochanter is allowed for by the glutei being attached to the front rather than the back of this process. When, however, the anteversion of the neck is excessive, is it not possible that these muscles tend to produce a rotation of the femur, a twist of the trochanter

backwards, which has to be checked either by excessive action of the abductor muscle fibres lying to the front, or a diminished action of those behind the plane of movement ? The result might well be a functional weakness of these muscles. A further point is that the head, even if stable as regards further upward displacement, is unstable in the antero-posterior direction, as is suggested by the greater size of the false acetabulum in the horizontal plane than the size of the head demands. As the trochanter tends to rotate backwards during abduction, so the head would tend to slide forwards. If a

FIG. 221.—Unilateral case to show leverage. The distance (H T) from the centre of pressure on the head to the trochanter—in the transverse plane of the body—may be normal, but is diminished if the neck is short or the head flattened, and also when the antetorsion is excessive. The shorter this lever, the weaker the abductor power of the glutei. The second lever (H I), formed by the ilium and measured from the head to the top of the crest, is always diminished, and often very markedly so. Even though the first lever happens to be normal in length, the inevitable diminution of the second puts the abductors at a great disadvantage. Though only one of these levers comes into play at a time—according as the limb is moved on the pelvis or vice versa—the length of the other determines the direction of the abductor muscle fibres and therefore has great influence over their power. The third lever (H W), formed by the pelvis, is measured horizontally from the centre of pressure on the head to the mid-line, which is taken as passing through the centre of gravity of the body. Since the femur is always displaced outwards as well as upwards, this lever is always increased in length, and the load the abductors have to support is thereby increased. When the neck of the femur is of good length, and the upward displacement not extreme, this last factor is possibly the most important of the three. To sum up, in all cases the abductor muscles of a dislocated hip act under decided mechanical disadvantages.

bilateral case is carefully watched when walking, the upper ends of the femora can be seen to move regularly backwards and forwards. This instability of the head in all probability plays an important part in the production of the gait. It is well known that when the dislocated head lies further forward than usual, whether placed there by nature or by the surgeon, the gait is often surprisingly good. It seems possible that this may be due to the greater

antero-posterior stability as much as or even more than the better vertical stability of the head in such cases. I am not prepared to exclude any of these factors as playing a part in the production of the so-called limp, and each must be kept in mind when considering the treatment of a case in which reduction is impossible. There is yet another factor, however, which occurs to one as not unimportant. If we are correct in attributing to the obturators and their associate muscles the important functions of assisting to suspend the pelvis and to hold the femur pressed to it when weight is borne on the leg, these muscles must also at the same time tend to adduct the femur. If this is correct, the abductors not only have to support the weight of the pelvis, but also to check this adduction pull of the obturators, and this they are unable to do : hence, in part, the rolling gait and the positive Trendelenburg sign.

4. **Shortening.**—The shortening seen in a unilateral case may accentuate the limp, but does not account for it. Compensation for the shortening may diminish, but never corrects, the faulty gait.

PATHOLOGICAL CHANGES.

Now many of the anatomical facts referred to are secondary and pathological rather than purely anatomical changes incidental to the displacement of the femur from the socket. The difficulty is to say when changes of form in the head of the femur and false acetabulum end and arthritic changes begin. There is no doubt but that flattening of the head occurs in children, particularly the older ones, without pain or other signs of arthritis, and I think we must regard such changes as due to altered anatomy rather than to arthritis. On the other hand, there is abundant evidence in the experience of every surgeon of the development of gross osteo-arthritis in the false joint. Many surgeons, however, including myself, have been impressed with the frequency of pain and other signs of arthritis in a congenitally unstable or subluxated joint previously regarded as normal, while the opposite hip, completely dislocated, gives no trouble.

Now the arthritis which occurs relatively late in life is essentially traumatic and the result of instability, but what of the cases that develop pain comparatively early ? Is this pain merely a strain pain, or is it arthritic in origin, and if the latter, is this arthritis infective or simply the early stage of osteo-arthritis ? If due to strain and to stretching of the capsule, insufficiently assisted by the muscles, we should surely expect to find that it is accompanied by further displacement of the femur, but, so far as I know, evidence of this is lacking. It is possible, and I think probable, that the pain in such cases is due to muscle tiredness rather than to stretching of the capsule. Walking is a great effort, especially when the deformity is bilateral. These patients often walk late, and cannot walk as far as normal children of the same age. When increase of weight occurs at puberty, perhaps accompanied by somewhat impaired health, it is not surprising that greater discomfort is experienced. Pain in the back experienced by older children may also be due to muscle strain, but occasionally it is sacro-iliac in origin. At the same time definite arthritis, more suggestive of infective than simple traumatic arthritis, does occur at a comparatively early age in a few cases. I

have met with villous arthritis at the age of 13 in an untreated case. The head of the femur in this patient displayed but slight erosion and no lipping, the synovial membrane alone showing any marked change. *Fig.* 222 shows the changes that had taken place in the head of one femur, the left, in the course of twelve months in a patient of 23, who could not walk without assistance. On opening the joint, blood-stained fluid escaped, though no manipulation had been done; the erosion of the cartilage was evident, the synovial membrane was gelatinous-looking and shaggy, but not villous, while the head had soft areas in it. This hip had been regarded as normal in childhood, when the other was unsuccessfully treated. This patient was delicate-looking, but without any discoverable septic focus.*

FIG. 222.—Bilateral dislocation in a woman of 23. The right hip had been treated in childhood; the left was undiagnosed. Note irregularity of outline of left femoral head, not present a year previously.

I feel sure that the general health of the patient, particularly as regards septic foci, is a very important factor—possibly the determining factor—in the incidence of arthritic trouble at a relatively early age. Experience of arthritis after reduction gives some support to this view, though trauma as a factor necessarily comes into the picture. If sepsis is not the decisive factor, how can we account for those cases, by no means rare, in which a woman with one or both hips dislocated will reach the age of 35, 40, or even more without any appreciable discomfort? To cite two examples: a woman of 35 in poor circumstances with bilateral dislocation married and had five children, one with a hip dislocated, but never experienced a day's pain; another woman, in better circumstances perhaps, had a dislocated left hip, was the mother of eight children, and had no pain till she reached her 45th year. Unfortunately there seem to be no statistics available as to the frequency of gross disability in cases past their childhood. At present I am not convinced that the pessimistic views held by many, probably by most, surgeons

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* Since this lecture was delivered, this patient has developed *infective arthritis* of one wrist.

as to the future of the untreated case are correct. I admit the serious disability experienced by many, but I do feel that we should not forget that there are quite a number of cases who live well into middle age with little or no discomfort. Unsuccessful attempts at reduction or transposition must, I think, be regarded as increasing the probability of arthritic changes developing. This must be kept in mind when a case is not seen until after the usual age limit for reduction is passed. Pseudo-coxalgia in the untreated case has not been met with either personally or in the literature, though it is relatively common after reduction. I have no experience of the incidence of specific infections such as tubercle, and the literature gives little help. Caesarono[32] quotes two cases of tubercle supervening in a dislocated hip, but in only one of these was the nature of the infection definitely proved.

TREATMENT.

Now let us turn to the treatment and see whether any of the above facts and theories can help us. The objects of treatment are two : (1) To provide a stable joint and obliterate the limp ; and (2) To diminish the chances of

FIG. 223. —Radiogram of congenital dislocation of left hip, twenty years after reduction at age of 2¾ years.

arthritis supervening. Both these objects are undoubtedly best served by manipulative reduction *at an early age*. If the hip is reduced before the age of 3, and better still before the age of 2, and a permanent cure results, in a very large percentage of cases the hip will be approximately normal and stand the wear and tear of life almost—though probably not quite—as well as a hip that has never been abnormal. *Fig.* 223 shows the condition after twenty years in a case reduced at nearly 3 years of age. It is now almost

twenty-six years since the operation was performed and the patient has a hip that is perfect in every way. *Fig.* 224 shows a hip reduced twenty-two and a half years ago, at the age of 3½. There is a slight increase in size of the femoral head on the dislocated (right) side, but otherwise it would pass as a normal joint. The patient is now a domestic servant, leading a very hard life, with a lot of running up and down stairs, and she says she is tired out by the evening, and then feels the hip that was dislocated. Other similar cases with perfect anatomical results have told me that if they get tired out the reduced hip always troubles them first.

Fig. 224.—Radiogram of congenital dislocation of left hip twenty-two and a half years after reduction at the age of 3½ years.

The older the patient at the time of reduction, the greater the chance of an imperfect anatomical result. In such cases we have achieved our first object, but in all probability have failed in our second. Putti[33] says a congenital hip should be treated as early as possible—that is, as soon as the diagnosis is made—but I am not convinced that there is any advantage in reducing the hip before the age of 18 months, and there are many obvious disadvantages. In most cases the head enters the acetabulum over its posterior margin, after having been brought down to rest on the ischium, over which, as we have shown, the joint cavity extends. If it can be lifted in, as it often can be in the youngest children, before the limb is abducted, so much the better. The synovial fold which, if present, descends in front of the head in the more difficult cases suggests we should take advantage of Ridlon's[34] method of thrusting downwards the fully flexed thigh—the knee being towards the opposite axilla—rather than rely on the abduction leverage method alone. It seems rational, considering the way in which the anterior part of the capsule is stretched across the acetabulum like a lid, that after the head has been apparently reduced, further abduction movements combined with rotation inwards and outwards should be carried out, in order to stretch up this lid and get the head well home. To be convinced of the advantage

of these manœuvres one has only to test the stability of the reduction before and after they have been performed. This seems to me an important part of the operation.

Now there is a growing tendency in the United States, and signs are not entirely wanting of the same tendency in this country, to favour open reduction not only when manipulative reduction has failed, but almost as a routine, even in the youngest children. The decision for or against open operation depends very largely on the view held by the individual surgeon as to the degree of development of the capsular isthmus in young children, and the obstruction this offers to reduction. In 1903 Sir Robert Jones,[35] in the course of the discussion on Burghard's[36] second paper advocating open operation, is reported as having expressed the following opinion : " The causes of failure were . . . sometimes constriction of the capsule, the importance of which was over-rated ". I understand Sir Robert still holds the same views, and I venture to endorse them emphatically. The results of manipulative reduction prove conclusively that in the youngest children at any rate, the reduction is complete in the vast majority. Is it right to inflict the extra risk of an open operation on all because very occasionally—and we must admit this—capsular constriction, an abnormal ligamentum teres, or some less obvious factor prevents a stable reduction being obtained by manipulation ? Simple open reduction, which we owe to Burghard, whose operation comprised the important details of dividing the psoas and enlarging the isthmus, is unquestionably a useful procedure in selected cases, rarely met with before the age of 4, though more commonly afterwards. Even with the help of open reduction I do not think the age limit of 6 for a bilateral and 9 for a unilateral case should be exceeded. Galloway[37] has been the strongest advocate of a more extended use of this method in recent years, but I am not sure that his published results give much support to his views. For instance, he reported a further series of 38 hips in 1926. Of these, the cures were 15 (less than 50 per cent, be it noted), the good results 18, the doubtful 5, and failures none. It is not clear what exactly constitutes a good result which is not a cure and yet not a failure. It must be insisted upon that open reduction *per se* has no advantage whatsoever over the closed method, reduction being complete in both cases. After both the acetabular margin must grow out, and for this prolonged fixation is necessary.

The next question involves the importance of antetorsion, the influence of this on the results, and the advisability of correcting this deformity by osteotomy. Opinions differ widely. Lorenz,[38] Bradford,[39] and Gill[40] all regard it as unimportant, the first going so far as to say that its correction may lead to posterior subluxation. On the other hand, most writers are not prepared to disregard it, though they differ as to how, when, and where it should be corrected. Osteotomy is the usual method adopted, but Galleazzi[41] claims to correct it by plaster in inversion and active and passive exercises. Soutter and Lovett[42] say antetorsion improves with weight-bearing, especially after two or three years. Hibbs,[43] Calot,[44] and others do osteotomy in the lower third of the bone, while Froelich[45] snaps the atrophied femur over the edge of the plaster some months after reduction. Others divide the bone in the upper third. Schede[46] and Codivilla[47] use a nail driven into the trochanteric

region, to control the upper fragment. As to the degree of antetorsion demanding correction, Durham[48] operates on anything over 45°, while Werndorf[49] puts the limit at 60°, and Bradford and Lovett[50] say 90° antetorsion is incompatible with normal gait and must be corrected. Our experience is that if hips are reduced·early, say before the fourth year, it is excessively rare to meet with a case which demands osteotomy. In the older cases, which should become less and less numerous, a degree of antetorsion of real importance, i.e., over 45°, is more common, but still rare. Failure of the upper lip of the acetabulum to grow out seems to me a far more potent factor leading to re-dislocation than any deformity in the femur.

The next problem is : Should anything be done, and if so what, to the adolescent or young adult with this deformity who suffers little or no discomfort, and never complains of real pain ? In a previous paper[60] I produced evidence to show how far from perfect were the anatomical results after reduction in the older cases, even though the head of the femur, or what was left of it, remained in the acetabulum. Gross erosion from 'absorptive arthritis' was present in most. Further experience has not led me to alter the opinion then expressed—namely, that it was more than doubtful whether much good had been done ; in fact, it was probable that actual harm had resulted, and that the grossly abnormal joint was even more likely to give rise to pain, and this at an early age.

Hey Groves[51] has suggested leaving the capsule intact around the head, separating it from the bone, and shifting it down to the acetabulum enlarged sufficiently to receive it. So far no detailed results in a series of cases treated in this way have been published. Though this ingenious method might be useful in an occasional selected case over the age limit given above, I can see no advantage in it over open reduction, coupled with a bone-grafting operation to make an upper lip, when the femur can be brought down to the requisite level. Unless this last can be achieved with reasonable ease it is better to leave the femur where it is. This brings us to the question of the bone-graft or bone-flap operation, first performed, according to Epstein,[52] by Koenig in 1891. The formation of an artificial lip to the acetabulum is a most useful operation, and is being performed with ever-increasing frequency by surgeons throughout the world. It is sound from the anatomical point of view. The making of an efficient shelf is comparatively easy ; the difficulty lies in making the shelf at precisely the right level. When relapse is seen to be occurring after manipulative reduction followed by prolonged fixation, or when simple reduction offers but little hope of a cure—for example, in a subluxated hip at 4 to 6 years of age, this operation is invaluable (*Figs. 225, 226*). The procedure should always be added to open reduction when the condition of the patient permits.[60] Anterior transposition, or the shifting forwards of the head towards the anterior inferior spine, by forcible manipulation under an anæsthetic, is practised by many surgeons in irreducible cases. By moving forward the point of support and increasing the range of extension and abduction the gait may be greatly improved. We have found this a difficult thing to achieve, and moreover relapse may occur. Lance suggests it is best suited to young adolescents just too old for reduction. Galeazzi[53] and Loeffler[54] both prefer open transposition. Adduction and flexion deformity

are, however, more satisfactorily corrected by osteotomy, at any rate in a unilateral case. The chance of arthritis in the future is not materially lessened by either of these operations, while in the former it may well be increased.

FIG. 225.—Unilateral congenital dislocation before operation. Age 5¼ years.
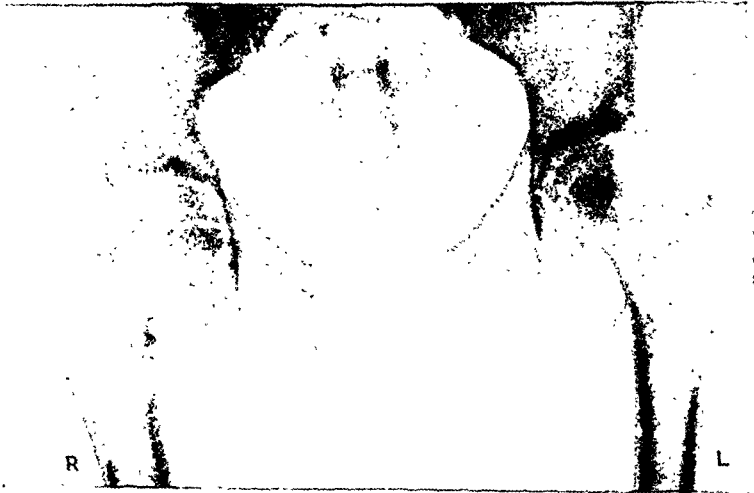
FIG. 226.—Case shown in *Fig. 225*, seven years after open operation for making an upper lip to the acetabulum.

Finally, we have to consider the difficult problem of the irreducible case which develops an increasing amount of disability and pain in adolescent or adult life. The difficulties are much increased when the deformity is bilateral, even though the symptoms be practically confined to one hip. It has already

been suggested that pain and greater disability may arise from muscle strain, but in all severe cases it probably results from arthritis. At the very least such cases must be regarded as potentially arthritic, and this must be taken into consideration in deciding what treatment to adopt. We have the following procedures to choose from : (1) Arthrodesis ; (2) Osteotomy ; (3) Shelf operation ; (4) Excision of the head of the femur.

1. **Arthrodesis.**—This is unquestionably the operation which offers, if successful, not only the best but the sole hope of permanent relief, and in unilateral cases it would seem to deserve first place. An exception might be made in the case of an adolescent with a moderate amount of pain and little or no radiographic evidence of arthritis. In such a case osteotomy of some kind might be preferable. It would seem to be wisest, when arthrodesis is decided upon, and the displacement is more than a mere subluxation, not to try to bring the head down to the acetabulum, but to gouge out a socket between the true and false acetabula. A moderate amount of difficulty in getting the head into the hole thus made for it is highly desirable, to ensure close contact of the bony surfaces. In a recent case operated upon bone-grafts were utilized over the head, both to increase the chance of ankylosis and to provide a good shelf supposing the bones failed to unite. In a bilateral case arthrodesis of the hip giving the greater amount of pain may be the only possible procedure. Anything short of this would run the risk of throwing more strain on the painless or less painful side, with the inevitable result of increased arthritis and pain. The necessity of preventing adduction of the unoperated side calls for fixation of the arthrodesed hip in but slight, if any, abduction. In a middle-aged patient we may even be forced into attempting the fusion in an adducted position.

2. **Osteotomy.**—In 1925 Lance[55] published a most valuable paper on this subject, and in it he discusses the relative value of the various osteotomies that have been tried for these cases. The possible methods are shown in the series of diagrams taken from his paper (*Fig.* 227). His decision is against the bifurcation operation of Lorenz[56] and in favour of the simpler operation of Froelich, since if the former is successful and the end of the shaft really enters the acetabulum all movement is practically obliterated. It seems probable that after the lapse of a year or two all osteotomies performed at or just below the trochanteric region would look very much alike in a radiogram. After osteotomy, contact of the femur with the pelvis in all probability takes place over the retro-acetabular surface rather than opposite the socket itself. It is difficult to believe, however, that any of these osteotomies can do much to relieve the arthritis or the symptoms thereof. What is the anatomical result of a bifurcation or other type of osteotomy ? If successful, the bent-in portion of the femur will take purchase against the pelvis, the weight being borne with the leg in the abducted position ; but it is doubtful whether the femur really hitches in the acetabulum sufficiently to take much of the weight, or that it does this for more than a few months. If the operation is successful in the obtaining of a new point of support, it inevitably follows that movement must be limited, and this limitation in many cases seems to be considerable. Where does this movement take place ? Either the femur hinges at the head, and the new 'articulation', if we may call it so,

allows forward and backward gliding movements, or the new articulation acts as the hinge and the head glides backwards and forwards, or gliding movements may take place at both. In any case some movement must take place at the head, and if arthritis is present, as we contend it is in most cases, is relief of pain to be expected? If movement is reduced to a minimum, I can understand considerable relief of pain being the result, but in that case is this operation any better than an arthrodesis except in so far as it is a much simpler procedure? There is, however, another possibility. When union has occurred after osteotomy and walking is commenced, the amount of abduction must tend to diminish, and if this takes place, the head of the bone will be levered outwards away from the ilium, the pressure between the
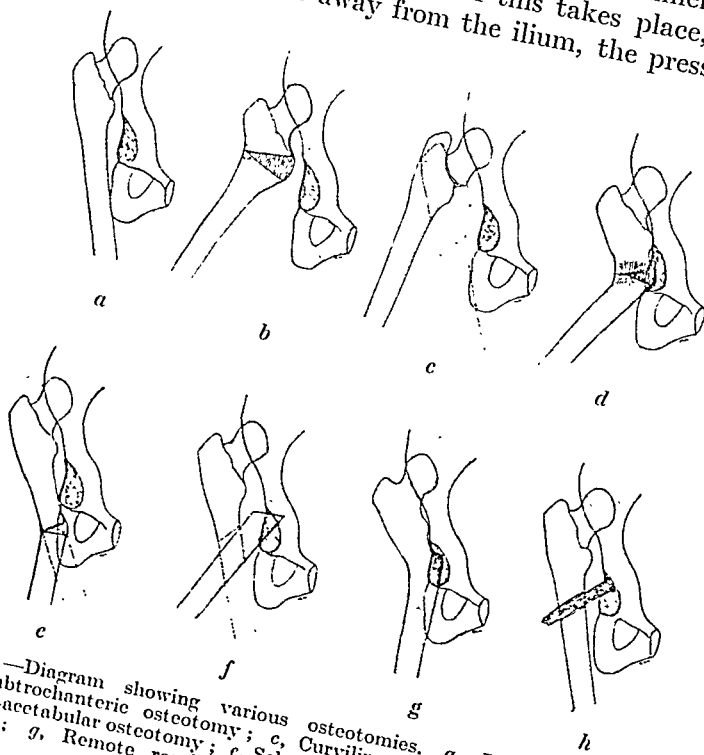
FIG. 227.—Diagram showing various osteotomies. a, Posterior dislocation; b, Kirmisson's subtrochanteric osteotomy; c, Curvilinear transtrochanteric osteotomy; d, Froelich's para-acetabular osteotomy; e, Schanz's ischiatic osteotomy; f, Lorenz's bifurcation operation; g, Remote result of Lorenz's operation; h, Maragliano's operation. (After Lance.)

two bones will be relieved, and thus the pain may be diminished or cured. As Girdlestone[57] points out in writing of pathological dislocation, the lower the osteotomy the greater the mechanical leverage that results.

Some of my friends are pleased with their results of the bifurcation operation in unilateral cases. Galeazzi, on the other hand, condemns osteotomy as mechanically unsound, and says the results are limited and transitory. There is so much difference of opinion on the value of osteotomy that I regret the more that my personal experience is insufficient to warrant a decision as to the value of this operation. So far as I can remember, only one case has been exhibited in London after a bifurcation operation, and this, a bilateral case, was not, I think, shown as a success. It would seem to me that

osteotomy is most likely to be successful, for a period of a few years at any rate, in cases a little over the age limit for reduction, whether performed to correct exceptional deformity or in the hope of relieving pain.

3. The Shelf Operation.—The so-called shelf operation for irreducible cases has been advocated strongly in recent years by Dickson, and to some extent by others.   Dickson[58] cuts the capsule freely away, applies mechanical traction, and endeavours to bring the head some way downwards as well as forwards, before turning down a shelf of bone above it.   If the head is already much damaged by arthritis, and this is certain to be the case where the patient is an adult and suffering much pain, can we expect the new joint to remain painless for long ?   However, Dickson is satisfied with his results, and gives details of one or two cases which were certainly greatly benefited by the operation.   So far as I know, he has made no further report since his original paper in 1924.   Mechanically this operation should increase the stability and improve the gait to a slight extent.   The stability might, I think, be improved by carrying the shelf in front of and particularly behind the head, and by shifting the trochanter forwards on the femur.   Although I have always doubted the soundness of this operation on theoretical grounds and have never performed it, I think there is one point definitely in its favour : even if it fails to give relief, or does so only for a time. it has prepared the way for a satisfactory arthrodesis.   In a bilateral case, when one side has been arthrodesed, it may be the only operation open to the surgeon.   Allison,[59] in a recent article, advocates the shelf operation as the best procedure in adult cases.

4. Excision of the Head of the Femur.—This operation unquestionably relieves the pain at once, and for so long as a weight-relieving caliper is worn afterwards.   When, however, the splint is discarded pain soon returns, while the limp is necessarily even worse than before.

To sum up : we feel that arthrodesis is unquestionably the best method and the only one likely to relieve the pain permanently, but that osteotomy is useful in a few selected cases.   The shelf operation, in the absence of any recent publication of the results in a series of cases, would seem to be still on probation.

SUMMARY.

In this paper I have endeavoured to call attention to the chief points of interest and importance in the anatomy of congenital dislocation of the hip.   In particular the changes in the bone behind the acetabulum, with the occasional formation of a facet at this spot, the arrangement of the capsule and the importance of the ischio-capsular band which forms a sling over the neck of the femur, have been pointed out.   The muscles which chiefly assist the capsule in slinging the pelvis on the femur are, I contend, the psoas in front and the obturators and their associates behind.   Factors which may contribute towards the production of the characteristic gait, and the causation of the pain experienced in later life, are discussed.   Finally, in a rapid survey of the treatment. the various operative procedures at our disposal have been criticized in the light of the foregoing facts and theories.

In these days of Child Welfare Centres, better diagnosis, and the ever-increasing practice of routine X-ray examinations, the number of cases of congenital dislocation left untreated till all hope of a cure is past is gradually diminishing. It cannot be insisted upon too strongly or too often that these cases must be sent to the surgeon early. Treated in early childhood the majority are cured by the manipulative method, and of the rest an ever-increasing number should be cured by open operation.

Is it too much to hope that the time will come, and that before many years, when every uncomplicated congenital hip will be˙ cured at an early age, and the difficult problems presented by the irreducible case, hopelessly crippled on reaching adult life, will cease to trouble the surgeon?

The author wishes to record his great indebtedness to the Curator of the Musée Dupuytren in Paris for permission to make free use of the numerous invaluable specimens of congenital dislocation of the hip in that museum.

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SPONTANEOUS RUPTURE OF THE NORMAL SPLEEN.

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So contrary is it to the established conceptions of pathology, that there are many who doubt that a normal spleen can rupture spontaneously. There is every excuse for such an attitude; at the most there are but eleven recorded cases (Table I) of the condition, and the first of these was published in 1919.

Table I.—ANALYSIS OF CASES OF SPONTANEOUS RUPTURE OF THE NORMAL SPLEEN.

AUTHOR	SEX AND AGE	THE NATURE OF THE RUPTURE	RESULT	MICROSCOPICAL EXAMINATION
1. Shorten	M. 43	Tear in splenic pulp	Recovered	Normal spleen
2. Connors	M. 38	Subcapsular hæmatoma	Recovered*	Not done
3. Metcalfe and Fletcher	M. 21	?	Recovered	Normal spleen
4. Metcalfe and Fletcher	M. 21	Rent in convex surface	Recovered	Normal spleen
5. Skerritt	M. 53	Subcapsular hæmatoma	Died	Not done
6. Atkinson	F. 35	Lower pole pulped	Died	Not done
7. Susman	M. 53	Subcapsular hæmatoma	Died	Normal spleen
8. Rhame[1]	M. 23	Rent in convex surface	Recovered	Normal spleen
9. Remynse[2]	M. 16	?	Recovered	Not done
10. Capecchi[3]	F. 27	Large rent in splenic pulp	Recovered	Apparently normal
11. Girling Ball, reported by Underwood[4]	M. 50	Tear on anterior surface	Died	Normal spleen

* Died four years later from pulmonary tuberculosis.   † Patient was four months pregnant.

In two of these eleven cases (Skerritt's and Atkinson's) the clinical notes are very briefly reported, and M. P. Susman,[5] from whose exhaustive study the above table is for the most part compiled, regards them as doubtful cases. This leaves us in possession of but nine authentic examples up to the present time.

The report of an additional case will help to consolidate the position of spontaneous rupture of the normal spleen as an established clinical entity.

CASE REPORT.

HISTORY.—On March 31, 1929. L. P., a male van driver, age 20, was seized with severe abdominal pain whilst sitting in a chair at home. Up to that time he had been perfectly healthy, except for a right-sided empyema in infancy. All his life had been passed in Birmingham. He is absolutely certain that he had not been involved in any accident or received any blow at work or play during the past year.

ON ADMISSION.—The patient was admitted to hospital eighteen hours after the commencement of the attack. He stated that the pain commenced in the umbilical

region and radiated to the right hypochondrium. Later the pain became more severe and radiated to the left shoulder, and for about ten hours persisted in the left shoulder as well as the whole of the abdomen.

ON EXAMINATION.—The temperature was 101° and the pulse 100. The abdomen moved normally with respiration. There was some general tenderness, maximal in the right hypochondrium, where rigidity was also located. On the left side there was a mal-descended testis within a hernial sac. This was tender, and the sac contained fluid opaque to transillumination. I went to some pains to exclude the possibility of torsion of the testis with hæmatocele. A definite diagnosis could not be made, and the patient went to the operating theatre as a case of ? perforated duodenal ulcer, ? appendicitis.

OPERATION.—Anæsthesia was induced by injecting 0·7 c.c. of stovaine intrathecally. A small gridiron incision was made. On opening the peritoneum pure blood escaped profusely, and it was then that the probability of spontaneous rupture of the spleen crossed my mind. The gridiron incision was closed. At this stage the

FIG. 228.—The patient six weeks after operation, showing the mid-line incision used for splenectomy.

anæsthetic was supplemented by a little gas and oxygen. A mid-line incision was made in the epigastrium, and on opening the peritoneum blood again poured out. The hand was passed into the left hypochondrium ; clots of blood floated up into the wound ; the spleen felt large, and left little doubt that the source of the hæmorrhage had been found. Splenectomy was performed. Handfuls of clots were removed from the left upper abdomen, but no attempt was made to engage upon the Sisyphean task of mopping up the fluid blood. The abdomen was closed, the operation being completed in under half an hour. Subcutaneous saline was administered at the close of the operation and continued after the patient had been returned to bed. There were no post-operative complications, and the patient is in normal health at the present time (*Fig.* 228).

The excised spleen is shown in *Figs.* 229, 230. The photographs clearly demonstrate a subcapsular hæmatoma which has burst. The histological examination (*Fig.* 231) of the organ was undertaken by Dr. Whitelaw, and he

reports that the structure is that of a normal spleen. Serial blood-counts were carried out by Miss Trought, B.Sc., and the findings conform with those of traumatic rupture of the spleen.
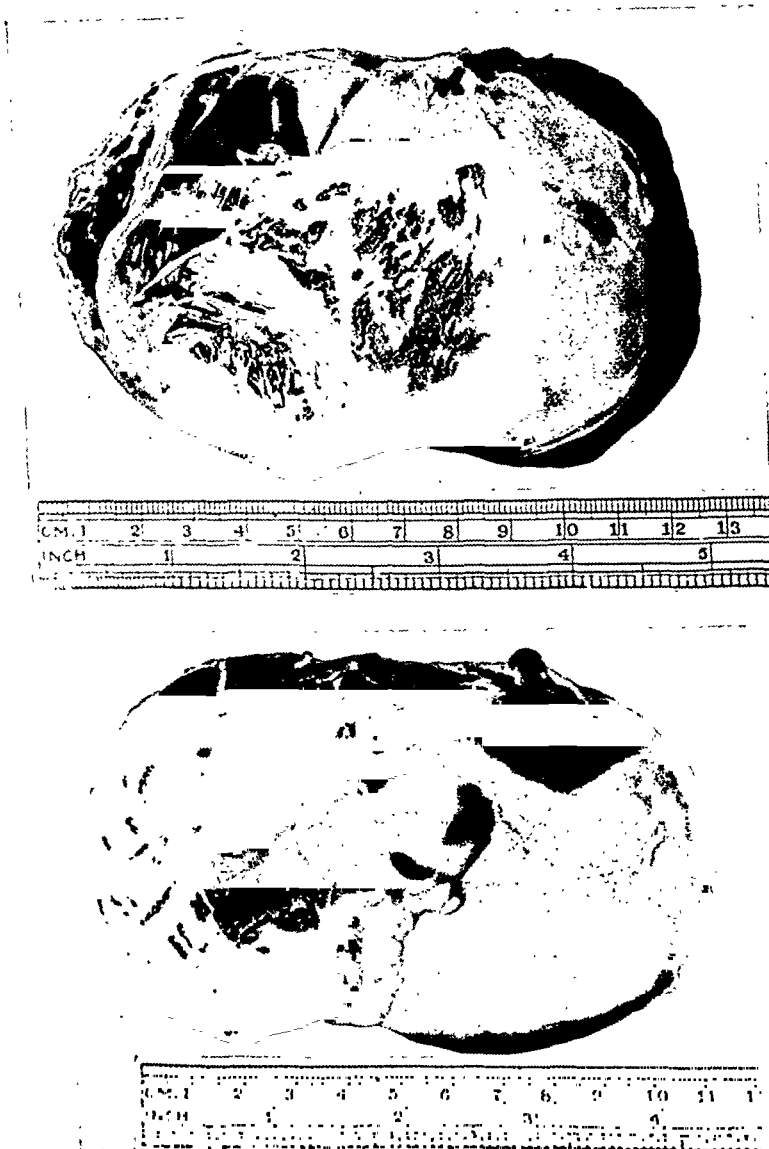
FIGS. 229, 230.—Spontaneous rupture of the normal spleen. The subcapsular hæmatoma which burst is well shown.

ETIOLOGY.

There are on record at least three examples[6, 7, 8] where, after successful splenectomy for supposedly *spontaneous* rupture, the investigator has been able to elicit the history of a blow. On the other hand, no such history was obtainable in my case, or in any of the cases included in the foregoing table.

An accident of sufficient magnitude[9] to rupture a normal spleen is unlikely to be forgotten by the recipient. To assume that all the patients whose spleen is alleged to have ruptured spontaneously had forgotten such an accident, or alternatively, had deliberately withheld information concerning it, seems impossible. Yet how else are we to account for the bursting asunder of a normal spleen? If the theory of an overlooked accident is discarded, we are plunged into a morass of speculation in which (on account of the great rarity of the condition) it is unprofitable to linger.

Only the spleen can behave in this curious manner, and from the practical standpoint there follows a good aphorism : "*In atraumatic hæmoperitoneum in the male examine first the spleen.*"
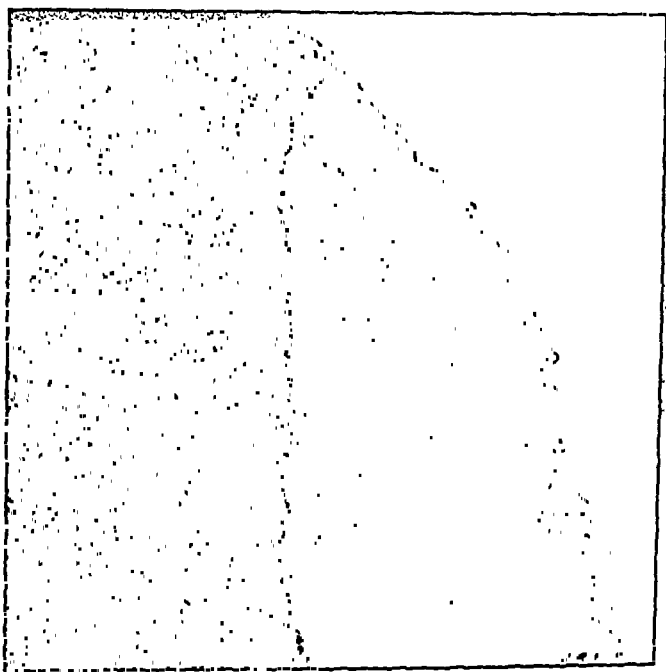
Fig. 231.—Section of the spleen, showing the subcapsular hæmatoma. (× 25.)

SPONTANEOUS RUPTURE OF THE SPLENIC VEIN.

On the clinical side spontaneous rupture of the splenic vein bears comparison with spontaneous rupture of the spleen ; pathologically the conditions are widely separated. The bursting of an engorged vein can be readily understood. In the only two examples which are available in the recent literature the liver was diseased, and as a consequence the venous pressure in the radicles of the portal vein would be increased.

Ogilvie's[10] patient was a clerk, age 31, who gave a history extending over eight years of attacks of jaundice. He was admitted into Guy's Hospital with an enlarged liver and spleen, and whilst in hospital suddenly presented grave acute abdominal symptoms. Laparotomy revealed a hæmoperitoneum.

and renewed hæmorrhage was controlled only after the splenic pedicle had been clamped. Splenectomy and autotransfusion failed to save the patient's life. Necropsy showed a malignant hepatoma with secondary deposits in the lung.

Pyrah, Stansfield, and Garland[11] have furnished another example.. The patient was a woman of 38 who died six hours after the onset of acute abdominal pain. At necropsy the peritoneum was found full of blood, the source of the hæmorrhage being a tiny hole in the dilated splenic vein. There was well-marked multilobular cirrhosis.

CONCLUSIONS.

1. A case of spontaneous rupture of the normal spleen is recorded.

2. Kehr's sign of left shoulder pain in ruptured spleen was well marked, although its diagnostic significance was not appreciated.

3. Yet another example of hæmoperitoneum with a comparatively slow pulse-rate is brought to notice

4. Additional evidence is afforded that the mid-line upper abdominal incision is adequate for splenectomy in cases of rupture.

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A PLASTIC OPERATION FOR FACIAL PARALYSIS.

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HON. OPHTHALMIC AND AURAL SURGEON TO THE ROYAL HALIFAX INFIRMARY.

So far as one can judge from a solitary case, the procedure described below is worthy of more extended trial. It is designed to ameliorate disfigurement and to ward off impending corneal ulceration in long-standing cases of lower-neuron facial paralysis, more especially those due to mastoid disease, or accidentally inflicted during mastoid operations. Suitable cases are rare.

Without leaving conspicuous scars, three new ligaments are grafted into the face, corresponding in position to the inferior portion of the orbicularis oculi, the levator palpebræ superioris alæque nasi, and the zygomaticus major.
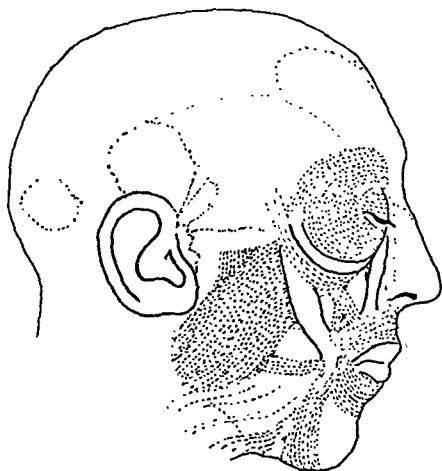
FIG. 232.—The muscles of expression.
(*After Cunningham.*)

FIG. 233.—Showing the strip of fascia lata *in situ*.

(*Figs.* 232, 233.) These sustain the drooping lower eyelid and palsied side of the mouth, and make them conform to a more pleasing facial expression. The material employed is a continuous strip of fascia lata. General anæsthesia is induced, and a 2 per cent solution of mercurochrome is applied freely and widely to disinfect the skin, conjunctiva, and buccal surface of the cheek. A probe is passed along the inferior lachrymal canaliculus, to define its position. The angular vein and parotid duct must also be avoided.

Two short incisions are made, exposing the temporal fascia and the internal palpebral ligament respectively. The latter structure—a familiar

landmark in the operation of excision of the lachrymal sac—is invariably well defined. A third tiny incision is made at the junction of skin and mucous membrane at the angle of the mouth. Meanwhile an assistant has been excising as long a strip of fascia lata as can possibly be obtained, 5 mm. in width, from the outer aspect of the thigh ; this is threaded along a triangular course between the three facial incisions, among the atrophied muscles, with the aid of a packing needle. The internal palpebral ligament and orbicularis oris are encircled en route. The two free ends are drawn taut, and woven into the fibres of the temporal fascia. The incisions are closed and the tension is temporarily relieved with adhesive strapping.

The result is not so good as is obtainable in cases of shorter duration by facio-hypoglossal anastomosis, but the method has one real advantage—its effect is immediate.

TOXIC GOITRE.

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ETIOLOGY.

A REASONED plan for the place that surgical procedure should occupy in the treatment of toxic goitre can only be made when the evolution of the disease is understood. There is not universal agreement on this point, but I believe that, apart from the inflammations and malignancy, thyroid diseases are linked together. The work embodied in this paper has been carried out in a clinical unit, and no claim is made to interpret difficult pathology. The difficulties of the interpretation of clinical conditions by examination of the pathological material are very great. Able pathologists are spending their whole lives at this problem ; Marine, Scott Williamson, Pearse, and many European investigators have done invaluable work. The difficulties of the problem are shown by the statement by Marine,[1] who has spent more than twenty years at work on thyroid pathology, that he has found it vain to use human thyroids (whether obtained at surgical operation or autopsy) as his starting-point ; while Scott Williamson and Pearse,[2] after stating some of the difficulties, write : " We would deprecate any attempt to solve these by reference to the clinical condition of the patient ; that is indeed the source of all confusion in pathological studies." These statements should scarcely be quoted apart from their context, but we have inquiring minds, and we have to treat people who are ill, and we have to teach students who have inquiring minds. I therefore cannot agree that the clinical condition of the patient should be ignored, and only the histopathological appearances used in the grouping of goitres.

Difference in the Types of the Disease.—The differences which may occur in the manifestations of toxic goitre in different patients have been noted by all observers, and much ingenuity has been shown in accounting for them. These are so obvious as to suggest two diseases, one being called 'exophthalmic goitre' (*Fig.* 234), the other 'toxic adenoma' (*Fig.* 235). Not only are the manifestations in characteristic instances of the two types strikingly different, but the two types tend to occur at different periods of life ; the so-called exophthalmic goitre, with its staring eyes, pronounced nervous symptoms, rapid but usually regular heart rhythm, being most common in early adult life. On the other hand, the so-called toxic adenoma is rarely associated with exophthalmos, the nervous symptoms are comparatively mild, but the heart rhythm becomes irregular, congestive heart failure is not uncommon, and this syndrome tends to occur about the period of life usually associated with the menopause—on an average two decades later than the onset of primary exophthalmic goitre.

There are, however, facts—I use the word 'facts' advisedly—which have always troubled some of us. We have tried to force cases into a type, and it has left us with an uneasy feeling from time to time that a case would not

FIG. 234.—Primary toxic goitre ('ex-ophthalmic goitre').

FIG. 235.—Toxic goitre ('toxic aden-oma') : no exophthalmos, auricular fibril-lation of nineteen months' duration.

FIG. 236.—Primary toxic goitre with no eye signs.

FIG. 237.—Bilaterally symmetrical goitre ('toxic adenoma'): no eye signs, auricular fibrillation.

fit in, notwithstanding that many did so readily. As examples, there are patients of the so-called exophthalmic type without exophthalmos (*Fig.* 236), and of the so-called toxic adenoma type with no obvious adenoma, but with

a diffuse goitre (*Fig.* 237).

FIG. 238.—'Toxic adenoma': one single nodule, the remainder of the gland apparently normal.

The eye signs vary in degree. There may be extreme proptosis, or the slight but unmistakable lift of the eyelids without proptosis, or there may be no eye sign present. Again, in the so-called toxic adenoma group, in a typical example there is present a single adenoma (*Fig.* 238); but another with similar symptoms will have an irregular adenomatous mass (*Fig.* 239), a nodular goitre more or less bilateral, or a bilaterally symmetrical goitre in which the irregularities of surface are so slight that it feels almost smooth (*Fig* 240).

FIG. 239.—'Toxic adenoma': auricular fibrillation; an irregularly shaped unilateral mass.

FIG. 240.—'Toxic adenoma': auricular fibrillation, no exophthalmos; bilateral enlargement, almost smooth.

One Single Disease.—Lengthening experience, with observation of patients suffering from toxic goitre, followed by operations upon them, examination of pathological material removed, together with the later histories, have compelled me to believe that these patients do not belong to two distinct groups; and that the difference, striking though it may be in extreme cases, is of degree only and not of kind. My belief now is that a full range of cases exists representing every stage between exophthalmic goitre at one end and toxic adenoma at the other, and that we can observe in a graded series of patients exophthalmos and central nervous system symptoms becoming less and less until they almost or entirely disappear. Corresponding with this we can observe the thyroid gland become less smooth and symmetrical, and become more nodular. until we reach a gland with a single adenomatous mass (*Fig.* 241).

These transitional forms are not so few in number that they may be ignored; they are as numerous as those of the so-called exophthalmic or toxic adenoma type. I believe that we are dealing with one disease whose manifestations differ under differing conditions. and that these conditions depend upon factors some of which are well-defined and some of which are not yet clear, and that these factors are three. I propose to examine each, and to show the response to surgical treatment in some groups of cases in which the patients have reached an extreme degree of disability. and the reasons why

the response to surgical treatment is conditioned by the three etiological factors.

Nomenclature.—Parry described the disease accurately in 1786, Graves in 1836, and Basedow in 1840. I shall employ the words 'toxic goitre' to replace these names* and also the terms exophthalmic goitre and toxic adenoma, because the only two facts about which there can be no argument are, first, that there is a goitre, and, secondly, that there are evidences of toxicity referable to the goitre. The word 'hyperthyroidism'—that is, excess of normal secretion[3]—which occurs so constantly in the literature, may, or may not, express the condition present in some patients. With the evidence
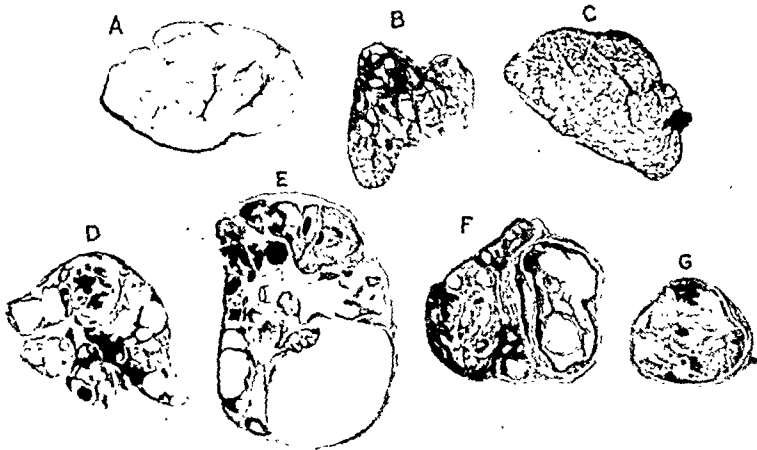
Fig. 241.—A series of *specimens removed at operation*, showing the gradation from primary toxic goitre (exophthalmic type) to secondary toxic goitre with a single nodule (toxic adenoma type).

A, Primary toxic goitre—bilateral, smooth (exophthalmic type). B, Secondary toxic goitre — early type — exophthalmos—bilateral—smooth—scattered areas of hyperplasia. C, Secondary toxic goitre—early type—exophthalmos—bilateral—smooth—no solid areas visible to the naked eye—appears completely colloid. (Patient, *Fig.* 256; sections, *Figs.* 252, 253, 254. D, Secondary toxic goitre—later type—bilateral, becoming nodular to palpation—no exophthalmos—auricular fibrillation for four years. E, Secondary toxic goitre—unilateral—very big, irregular masses—auricular fibrillation eight years—œdema extensive. F, Similar to E, but smaller and smoother. G, Secondary toxic goitre—one single smooth nodule—typical 'toxic adenoma' type.

at present available I emphatically believe that it does not, and that the disease throughout its whole range is a toxic state. Some qualifications of the term 'toxic goitre' will be necessary, but these qualifications need be only of the simplest, and employed in order to indicate whether the disease is a primary or a secondary condition, and whether, if secondary, the condition is an early or a late one. A 'secondary' condition implies that the thyroid

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* The term 'exophthalmic goitre' is so descriptive, and both it and the name 'Graves' disease' are so firmly established, that they will certainly remain permanently; although if the disease is to be associated with the name of an individual, should it not be that of Parry ?

gland has been the seat of a non-toxic goitre before toxic manifestations occurred. Throughout the literature of toxic goitre there has been much argument as to whether the disease is essentially of the thyroid gland[4] or whether the gland changes are part of a general disorder. Let me say at once that I believe that the stimuli which bring about the disease are situate without the gland, and that these stimuli affect the gland, causing such change in its structure and function that its secretion is altered, and consequently other organs are intoxicated by its altered secretion. The enlarged thyroid itself, together with the intoxication of the other organs, give us the manifestations of the disease.

Three Primary Factors. — We have therefore three factors present: (1) The stimuli; (2) The thyroid gland; (3) The organs affected by the disordered secretion.

The First Factor: the Stimuli.—A normal thyroid gland functions in response to normal stimuli in a properly balanced body. We have some evidence that normal stimuli can become excessive and therefore abnormal, and that these abnormal stimuli affect the thyroid gland detrimentally.

The Second Factor: the Gland.—An individual may have a gland which is normal; or a gland which has already become a colloid goitre, or which by successive waves of stimulation has passed through stages of hyperplasia and involution and become a nodular goitre; or an otherwise normal gland may contain an adenoma. These changes are frequently occurring apart from toxicity or before any question of toxicity arises; and on to a gland in any one of these states, or any combination of these states, there may be directed the pathological stimuli which constitute the first factor. The reaction of the thyroid gland to these stimuli must vary within limits according to the amount and condition of its own epithelial elements at the time.

The Third Factor: the Cells of the Body.—Plummer has well said that the energy output of the cells of the body is determined by the secretion of the thyroid gland. So sensitive are these cells to the amount and quality of thyroid secretion, that differences in the amount or quality produce results that are obvious, and whose nature is becoming increasingly well known to us. For the purpose of this discussion, instead of taking the cells of the body generally, I am confining myself chiefly to the muscle fibres of the heart, for the reason that the heart is an organ influenced by thyroid secretion in a manner that can be observed, and to a great extent measured. This third factor of the heart before it is affected may also vary within wide limits.

My thesis is that the variations in these three factors and their inter-relationships give a sufficient explanation of the different types of toxic goitre—why in youth and early adult life we have the picture described as exophthalmic goitre; why this type becomes less frequent with succeeding decades, although it never completely disappears; and why the type described as toxic adenoma rarely occurs in early adult life but becomes the increasingly predominant type in the later decades. Let us take the three factors in more detail.

1. FIRST FACTOR: THE STIMULI.

The origin of the abnormal stimuli that affect the thyroid gland has troubled the clinician since the earliest recognition of the disease, and still there is little certain evidence. We have elicited some facts; some things we can only suspect. Let us first take the facts :—

1. The gland contains iodine, and the administration of iodine can affect its histopathology and physiology. In the disease we are discussing, its administration can cause a striking change in the clinical picture. Iodine undoubtedly has a profound influence on the gland.[5-8]

2. Marine[9] showed years ago that a goitre could be produced in fish at will, and more recently McCarrison[10] has been able, by feeding experiments with deficiency of manganese, to create the histological picture of a pathological gland in approximately 25 per cent of cases (*Fig.* 242).
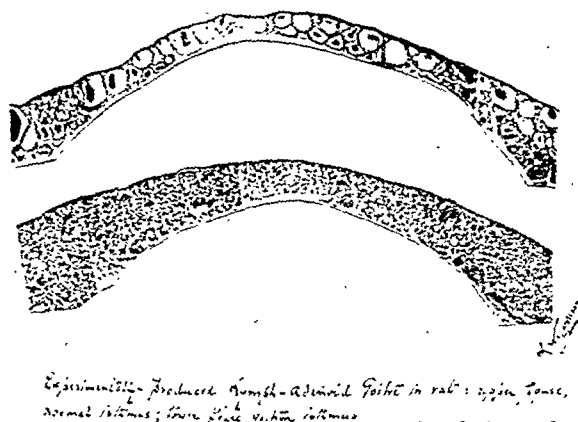
Fig. 242.—Experimentally produced lymphadenoid goitre in rat. Upper figure, normal isthmus; lower figure, goitrous isthmus. (*McCarrison.*)

3. Rupert Farrant[11] began to show, and Cole and Womach[12] have demonstrated, that acute infections quickly affect the histology of the gland. Add to this that an acute infection. such as tonsillitis, occurring in the course of the disease immediately sends up the pulse-rate and obviously increases the gravity of the other symptoms. I have seen a gain in weight of two stones follow the enucleation of infected tonsils during the course of the disease, and amelioration of the symptoms has repeatedly followed this procedure.

4. It is common knowledge that in some women visible enlargement of the gland occurs at the periods of physiological activity of the reproductive organs. We cannot doubt that an intimate relationship exists between the reproductive organs and the gland.

5. We know how psychic states can affect the disease. I have seen unhappy family life cause repeated exacerbations, finally ending in death, in a young person. and we have all seen the improvement that follows physical and mental rest.

Now we leave what we know, and consider what we can only suspect. What Marine and McCarrison achieve experimentally may be happening to anyone, and is certainly happening to some through unconscious diet deficiencies. There may be deficient intake of iodine or manganese, or indeed of other necessities which we know not of ; or, even if there is an adequate intake, part of this may be deflected from its normal course and used up in such ways that sufficient never becomes available for the thyroid. Marine and McCarrison have not shown that the experimentally produced change in the histopathology of the gland is ever associated with thyrotoxicosis, but a gland such as they show has ceased to be a normal gland. Also there are added from time to time infections. The evidence is clear that these further damage the gland, and in some few these damages through lack of chemical balance, and through infections, may hinder the gland from standing up to subsequent strains. For in this world the subsequent stresses and strains come, and, in relation to this disease, two types of them are predominant : the psychic and the sexual. Normal cerebral balance becomes disturbed by what may be called psychic trauma—the mental distresses suffered by sensitive people ; the mental conflict constantly undergone even by some who are not unduly sensitive, through the disorganization of the affections or business or health. Let me instance a girl of 18 who was compelled to live with an uncle who was very difficult. She lived in great unhappiness, and had no rest except when in hospital. We watched her through several exacerbations of the disease, and in one of these she died. These cases could be multiplied, but it is not necessary. Now consider sexual troubles. We have noted that sometimes the thyroid gland alters in size with menstrual periods. The development and control of sexual balance 'is not perfect in all of us. Our American colleagues have coined a suitable phrase—'sexual imbalance'. With some this may be absent, development and control going on perfectly and almost subconsciously. With others it is otherwise. In some it is a question of thwarted affection. I have seen young women in whom I am compelled to believe that the disease started when the parents continued to forbid an engagement. In others the difficulty is sexual urge. A surprising proportion of the men who have suffered from this disease have voluntarily told me of their mental turmoil. They live in an atmosphere of sexual introspection, and do not appear to obtain peace. I have never felt it wise to probe into these affairs, because I know of no remedy for our inherited desires.

I cannot tell you that these are the causes of Graves' disease.* Most people go through all these troubles without falling victims to the disease, but I have found one or another of them looming largely in most patients. The point I want to bring out at the moment is not the ultimate cause, but the incidence of the factors at the different periods of life. The food and chemical factor is present throughout life. Infections are always with us. The physiological stresses and the passions are strongest in the early years of adult life. The cerebral cortex reacts to them more intensely, and their effects are felt more keenly at this period. May this not be the reason why

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* The disease does occur in early childhood. It is difficult to explain the origin of the pathological stimuli at this age.

primary Graves' disease is much more frequent in the earlier decades of life? (This point will be referred to again when discussing the variations in the 'second factor'—the thyroid gland). Do these passions cease with age? Not at all, but much of their intensity lessens. Business and family worries may be great. Even sexually we are told that there is a dangerous age, but fortunately more tranquillity, even calculation, comes with advancing years. For these reasons, primary Graves' disease can begin in the later decades of life, but in these later decades the primary disease is less frequent. When the primary disease does occur in later life it is, for reasons which will be given later, a much more serious condition.

2. SECOND FACTOR: THE THYROID GLAND.

Most people commence life with a normal thyroid (*Fig. 243*), but a diffuse colloid goitre may occur early in life (*Fig. 244*). This, as de Quervain[13] and others have shown, gradually begins to change into a nodular goitre about
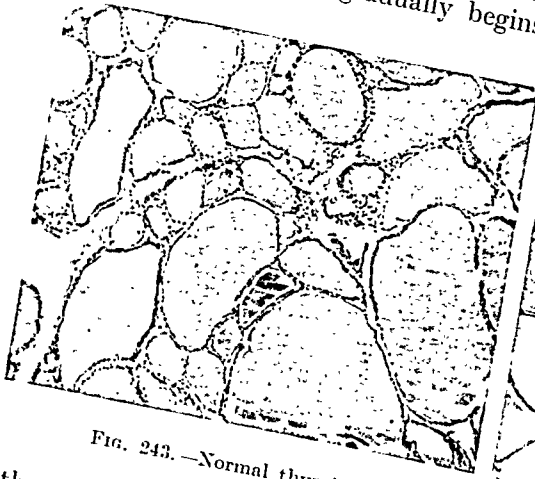
FIG. 243.—Normal thyroid.
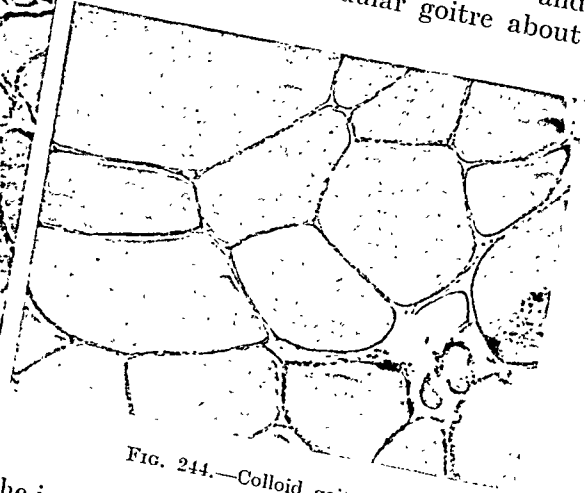
FIG. 244.—Colloid goitre.

the third decade (*Fig. 245*). Through the increase in the fibrosis, and localized hyperplasia followed by involution, this ultimately may become fibrocystic. Rienhoff and Dean Lewis[14] have elaborated this, showing further the development of colloid adenomas (*Fig. 246*).
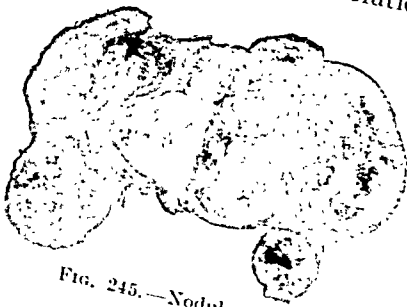
FIG. 245.—Nodular goitre.
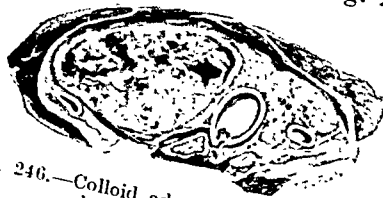
FIG. 246.—Colloid adenoma from a specimen obtained post mortem.

Again, a fœtal adenoma can exist in an otherwise normal thyroid gland. A gland in any one of these conditions may come under the influence of the

pathological stimuli which I have indicated as probably constituting the 'first factor' in the production of toxic goitre. The earlier in adult life this occurs, the more normal the thyroid epithelium will be; the later in life it occurs, the more likely is the gland epithelium and reticulum to have been affected already by waves of activity and involution. The gland may be in some stage of exhaustion. It is obvious that the histology of the thyroid gland, apart from any question of toxicity, may vary within wide limits. Its reaction to pathological stimu-
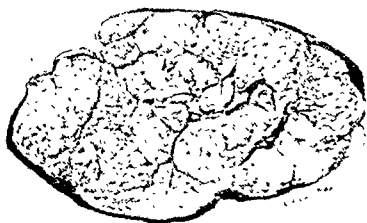
FIG. 247.—Primary toxic goitre (exophthalmic type): macroscopic.
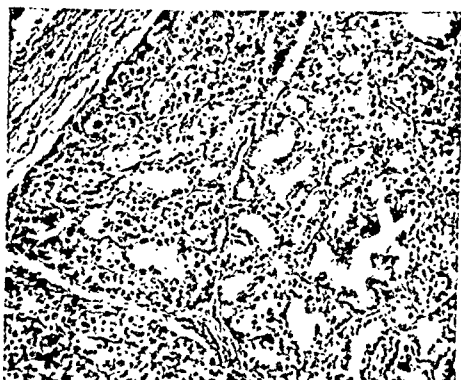
FIG. 248.—The same gland as shown in *Fig.* 247: microscopic.

lation must depend on its own condition when the stimulation begins to affect it. If the gland is a normal one, the whole gland can respond, and we see the picture which I have hitherto called a 'primary exophthalmic goitre' (*Figs.* 247, 248); which Scott Williamson and Pearse[2] have called an 'adenoid goitre'; which Wilson, Marine, Rienhoff, Dean Lewis, and many others have described, and

FIG. 249.—Secondary toxic goitre— early (exophthalmic): scattered areas of hyperplasia.

FIG. 250.—Secondary toxic goitre—early: apparently all colloid, exophthalmos. (Cf. *Figs.* 252, 253, 254, 256 from the same patient.)

which I now wish to call 'primary toxic goitre', or 'primary Graves' disease', or 'primary Basedow's disease'. If a thyroid gland is already in a state of colloid goitre when first affected by the stimuli constituting the first factor, its epithelium is already to some extent exhausted, and to some extent

destroyed. There is less of it, and what remains is incapable of reacting to the same extent as the normal gland could. Therefore we do not see the solid non-colloid gland which has been called primary exophthalmic goitre, yet the epithelium of the colloid goitre reacts to the stimulus to the extent to which it is able. But the macroscopic appearance will vary greatly; first according to whether the toxic change comes early or late after the occurrence of the colloid goitre, but also among patients at the same stages. There are
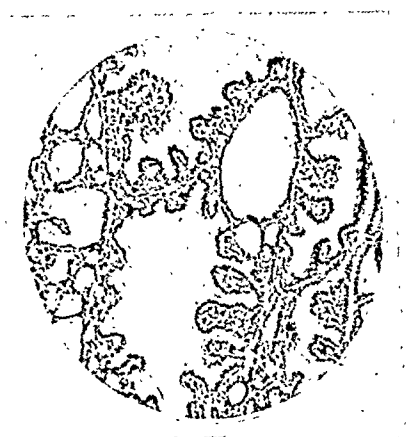
Fig. 251.—Secondary toxic goitre—exophthalmos. Lace-like type.
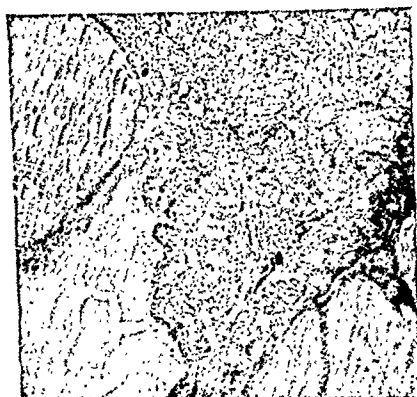
Fig. 252.—Secondary toxic goitre—early. Exophthalmos. Almost the whole gland consisted of large colloid vesicles with small scattered areas of hyperplasia. (Cf. *Figs.* 250, 253, 254, 256 from the same patient.)
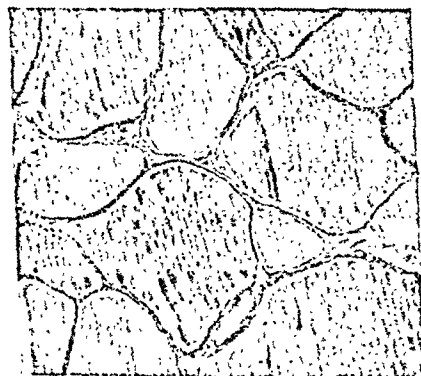
Fig. 253.—From the same patient as shown in *Figs.* 250, 252, 254, 256.

Fig. 254.—From the same patient as shown in *Figs.* 250, 252, 253, 256.

sometimes scattered solid areas of hyperplasia readily visible to the naked eye (*Fig.* 249). *Fig.* 250 shows one in which the whole gland appears to be still completely colloid, with no solid areas visible to the naked eye. Or the hyperplasia may be universal in the epithelium lining the vesicles—the type described as 'lace-like' by Rienhoff and Dean Lewis (*Fig.* 251).

Fig. 252 shows areas of hyperplasia in juxtaposition with large colloid vesicles. This is better shown in *Figs.* 253, 254, which are taken from different

parts of the same gland. These three sections are taken from the case shown in *Figs.* 250 and 256. They show how diverse the pathological picture may be. Occurring in young women, the clinical picture is scarcely distinguishable from that of the primary disease (*Figs.* 255, 256). This is because the stimulus is strong, and the thyroid epithelium is active enough to react to it. Why then call these other than primary Graves' (or Basedow's) disease ? Because the history and the pathological examination show them to be secondary, and because they constitute the first link in the connecting chain between exophthalmic goitre and toxic adenoma. The second link occurs when a non-toxic colloid goitre has become nodular before it is affected

FIG. 255.—Early secondary toxic goitre : exophthalmic type.

FIG. 256.—Early secondary toxic goitre : exophthalmic type. The greater part of this gland appeared to be colloid goitre. (Cf. *Figs.* 250, 252. 253, 254.)

by the pathological stimulus. The diffuse, colloid, non-toxic goitre of the earlier decades evolves into the diffuse nodular goitre of the later decades, because hyperplasia becomes localized on account of the inevitable fibrosis. Hyperplasia, involution with colloid storage, colloid degeneration, and fibrosis may all go on together in different parts of the same gland (*see Fig.* 245). De Quervain,[13] Scott Williamson and Pearse,[2] Rienhoff and Dean Lewis,[14] and others have described the transitional changes. At any time during these stages the gland may be affected by the pathological stimuli which we have called the 'first factor'; but two points must be noted : Firstly, by the fourth decade (and a colloid goitre rarely becomes nodular before the beginning of the fourth decade) the pathological stimuli are much less intense, for the reasons I have previously stated, and there is much less thyroid epithelium capable of responding to the stimulus; also, what epithelium there is, is less active. The stimulus is less, and the reaction to the stimulus is less. Therefore exophthalmos and the symptoms due to the central nervous system tend

to be less, and often are absent, so much so that the disease at this stage has been described as a different disease—a toxic adenoma. The cardiovascular signs and symptoms predominate, for reasons that will be stated later. Allen Graham[15] and Rienhoff[14] have each described the evolution of the single nodule toxic goitre (*Fig* 257).

It will be realized how great the variation in the 'second factor'—the thyroid gland—may be. It may be normal gland, colloid goitre, diffuse or unilateral nodular goitre; it may contain a colloid or a fœtal adenoma; it may be in any of these conditions, or in any transitional stage, when it is first affected by the 'first factor', the pathological

FIG. 257.—Late secondary toxic goitre, unilateral : toxic adenoma type.

stimuli. These two stages, the early and the late secondary toxic type, completely link the so-called exophthalmic goitre with the so-called toxic adenoma.

3. THIRD FACTOR : THE BODY CELLS.

As the example of the 'third factor' I take the muscle fibres of the heart. The reasons for this are that these cells are peculiarly sensitive to qualitative or quantitative changes in the thyroid secretion ; that the manifestations are such that every clinician is familiar with them ; that they progress from simple tachycardia to arrhythmia ; that to a great extent they are subject to measurement ; and that just as they progressively increase with the intensity of thyroid toxæmia, so return towards normal occurs with reduction in thyroid toxæmia. The young adult heart has great reserve power. Most individuals up to adult life and early middle age possess a heart with sound musculature, but by the fifth and sixth decades work, modern play, possibly child-bearing, influenza or other infective attacks, and age itself, have each contributed to the wear and tear of muscle fibre. The fact that mountain climbing, boat racing, deer stalking, and similar sports entailing heart strain have to be given up in middle age, drives home to us the fact that heart muscle can stand less than it could in youth and early adult life.

Importance of the Variation in the 'Third Factor' (the Quality of the Heart Muscle).—We have considered how the 'first factor'—the pathological stimuli—may vary within the widest limits ; how the 'second factor'—the thyroid gland—may also vary within wide limits ; how the 'third factor'— the body cells, of which at the moment we take as an example the muscle fibres of the heart—varies within equally wide limits before the impact of the altered thyroid secretion affects it. This altered secretion may be of high toxicity, but if the cardiac neuromuscular mechanism is young and unimpaired, tachycardia alone results, and, although this may be severe, the rhythm remains regular until, at long last, the reserve is broken down. If the heart muscle is older when the impact comes ; if it is fourth, fifth, or sixth decade muscle : if, in addition, it has undergone the vicissitudes of

work, strenuous play, and, perchance, illnesses, life will have levied tóll of its reserve, a slight degree of thyroid toxicity will break down its reserve, and irregularity of rhythm occurs early. If we look at the end-result we would say : " A very severe grade of intoxication." Not so : it may be a very slight grade of intoxication. The end-result is conditioned by the quality of the body cells on to which the intoxication is directed. The slighter degree of toxicity is the explanation of the infrequency with which eye phenomena occur — or the slighter degree to which they occur—in late secondary toxic goitre. In this late toxic goitre the 'first factor'—the pathological stimulus—is generally slight by comparison with its intensity in youth. It is directed on to a thyroid gland of which the parenchyma has been subject to involutional changes, the 'second factor' is at its minimum importance, and the resulting toxicity is therefore slight, so slight that it does not affect the eyes, and scarcely the central nervous system ; but the worn heart muscle with its reserve used up fails, and fibrillation occurs. The minimum effect on the eyes and the central nervous system, and the maximum effect on the heart mechanism, does not imply a different disease ; it is simply a difference in the ratio of the three factors.

Nothing that I have said precludes the possibility of a primary toxic goitre occurring in late middle age. A stimulus of sufficient intensity, and thyroid epithelium free from involutional changes (both of which are less usual in late middle life), can and does produce it, but it occurs less frequently with advancing years (*Fig. 258*). In a case of proposed operation a sharp distinction must be drawn between fibrillation occurring in late secondary toxic goitre and fibrillation in an elderly person

FIG. 258 —Primary toxic goitre in an elderly person.

with primary toxic goitre. There is a great difference in the surgical risk.

We seek for truth. We have not yet found it. There is much to perplex us. Not infrequently the removal of a single nodule, leaving the remainder of the thyroid *in situ*, has resulted in the disappearance of tachycardia, cardiac irregularity, and œdema. There is hyperplasia within the nodule. How does stimulation affect the interior of the nodule and leave the remainder of the gland comparatively nórmal ? Again, there is frequently hyperplasia in the tissue immediately surrounding the nodule. These facts for a long time made me subscribe to Plummer's view, but the steps in the gradation between these single nodules and the smooth symmetrical goitre of primary Graves' disease appear to me to be so complete clinically and pathologically that I cannot doubt that the view I have presented is more in accordance with the facts we are able to elicit in the present state of our knowledge. There are still many problems awaiting solution. Many writers have divided toxic

goitres into primary and secondary types. Some of the views put forward in this paper have been expressed by Allen Graham[15] in 1926, by Rienhoff[11] in 1927, by the writer[16] in 1927, and by Bérard[28] (Lyons) in 1929, each working independently. The absence of references to German work is due solely to my inability to read the language, but this article is in the main a record of personal views developed as the result of work carried out in the Surgical Professorial Unit at St. Bartholomew's Hospital. It does not contain a complete record of the literature of the subject.

SURGICAL TREATMENT.

PRELIMINARY CONSIDERATIONS.

It will have been realized from the evidence set forth in the first part of this paper that the disease is essentially the same whether the case is called primary or secondary, exophthalmic goitre or toxic adenoma, fully developed or *forme fruste*, any apparent differences being due to variation in one or more of the three 'factors' described. Nevertheless treatment must not be rigidly standardized, and must vary according to the clinical condition of the patient when the advice of the surgeon is first sought. I will state my usual practice briefly on the aspects about which there is little divergence of opinion, and discuss at greater length the question of auricular fibrillation, exophthalmos, permanence of results, extent of the operation required, preliminary treatment, and death-rate.

If the case is primary, operation is not performed in the earlier months. At this stage many patients recover with appropriate treatment; in some others the essential causes—the pathological stimuli—are still so active that operation would fail to achieve its maximum result. Septic foci are removed, adequate rest is given, and small doses of iodine are administered.* If the patient does not improve, or any sign of complication appears, operation is considered. The economic question is of importance. A well-to-do patient can afford time for rest, and may be willing to live a sheltered life with restricted activities, while a poor woman may be compelled to earn her living or manage her household. Visceral damage, while it may begin at any time in any patient, is therefore prone to occur earlier in the poor, and, both for economic reasons and to prevent or cure complications, operation must be performed earlier in the case of the poor. If operation is delayed too long, ultimate cure may be less complete.

If the disease is of the secondary type, nothing is gained by delay, and much may be lost. Operation should be performed as soon as the patient has been given sufficient preparation. This may be an arbitrary statement, seeing that the disease is essentially the same in each case; but when the disease is secondary, the thyroid gland has already been the seat of pathological change, therefore restoration to normal is less likely; also the patient is generally

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* Some surgeons object to the use of iodine except in the pre-operative period. Iodine with other appropriate treatment is very beneficial in early cases. Its use cannot be denied to physicians. In a case where operation is obviously indicated it is wise to withhold it until twelve or fourteen days before the operation.

older, the heart muscle is older, and for these reasons cardiac decompensation occurs more quickly, even though the degree of intoxication is less.

This view of the wisest time for operation is a personal one, and there are still sharp differences of opinion. It is good for us as surgeons that some patients desire X-ray treatment, and that others wish to continue medical treatment when we consider that the time for these measures is past and that operation is essential, for in this way our beliefs are continually being tested. But certain statements in publications which cannot be ignored would seem to show a lack of knowledge of the degree of disability in which patients find themselves, or—if this is known—of what can be done to help them. Let me mention four :—

1. Kessel, Hyman and Landl,[17] state that with ' skilful neglect ' the prognosis is excellent.

2. Barker[18] has stated that the course of the disease associated with diffuse hyperplasia of the whole gland—that is, primary Graves' disease— " is probably two or three years no matter how you treat it (medically, surgically, or radiologically)."

3. A surgeon[19] in a large provincial town in England very rightly asks, in a recent issue of the *Lancet*, " what the prognosis is in patients who decline operation ", stating, *inter alia*, that " the patient is not interested in the percentages of deaths and recoveries. What she wants to know is the prognosis without operation in her individual case."

4. The authors[20] of Jacobson's *Surgery*, after a balanced discussion, raise the question whether the benefit to be obtained from the operative treatment justifies the risk which is necessarily run. This volume also raises another point which I wish to discuss later—the extent of the operation, if performed.

These are very legitimate questions to raise. They crystallize the aspects of the subject that are profitable for discussion, and they merit a detailed answer. (I wish everything I say to apply only to those patients who have failed to respond to medical treatment.)

The reasons for operation come under two headings : (*a*) Economic ; (*b*) To prevent the grave complications of the disease, or to relieve them when present. Of the four published statements to which I have referred, the first three raise the economic question ; the fourth the prevention and the cure of the grave complications. (We should use the term 'sequelæ' rather than 'complications', for in many cases these grave symptoms are inevitable sequelæ, not something accidental.)

Regarding questions 1 and 2. I have taken a consecutive series of 300 patients coming for operation, and divided them into groups showing the duration of the disease in years. These are not all cases of *primary disease.*

LENGTH OF SYMPTOMS.

Over 4 years - 125 patients
Over 6 years -   89   „
Over 10 years -   62   „
and in 24 only was the history less than 4 years.

These 300 patients had had more than 'skilful neglect'. Each had sought the best treatment that, in her station, she was able to obtain. The result

for these patients has been great distress, and great economic loss for themselves, their families, and the community. I am keeping to facts, but in passing we should remember that of those who started level with this 300, we have no evidence how many recovered in Barker's two- or three-year period, nor, on the other hand, how many died.

Next, taking question 3. The writer states : " The patient is not interested in percentages of deaths and recoveries. She wishes to know the prognosis in cases where the patient declines operation." We all agree that some get well. A survey of the last 1000 patients operated upon by me reveals evidence of the condition in which many patients find themselves when operation has been delayed. I will mention briefly five groups : (1) Patients who develop eye complications other than exophthalmos ; (2) Those who develop glycosuria ; (3) Patients who develop mania ; (4) Those who develop auricular fibrillation—many with cardiac decompensation ; (5) Patients who die.

Fig. 259.—Chemosis and ulceration.

Group 1. *Eye Complications.*—I have had ten patients who developed corneal ulceration while still under treatment. *Fig.* 259 shows one in whom the conjunctiva was extruded to a degree in which it was ulcerated and almost strangulated. In some the eyelids were sutured together to prevent loss of the eyes, and separated when the danger was passed (*Figs.* 260 and 261). *Figs.* 262 and 263 show two patients in whom an eye was lost.

Fig. 260, 261.—In both these patients the eyelids were sutured together because of the imminent danger of loss of the eyes. In both, the eyes have receded following operation.

Group 2. *Glycosuria.*—Twenty-five patients have developed glycosuria, 9 of them very severely.

Group 3. *Mental Disturbance.*—Seventeen patients have developed mania. Five died in acute mania without operation; some developed chronic mania to an extent that made operation obviously unwise; some were operated upon while quite bad mentally. Only one who was operated upon failed to recover mental balance, and she had been in a lunatic asylum before operation—I did not know this at the time.

FIG. 262.—Loss of left eye.

Group 4. *Auricular Fibrillation.*—I have operated upon 131 patients with permanently established auricular fibrillation, and in most of these the disease had progressed to this condition while the patient was under observation and treatment.

Group 5. *Death.*— I have not kept a list of the patients who have died without operation, but I can recall 12 who on admission were either too ill for operation and died almost at once, or died while awaiting their turn for admission.

This is some answer to the question as to what the prognosis is in patients who have not been operated upon. Therefore I think we can take it that, after allowing for those who respond to other methods of treatment, some patients remain gravely ill, and for these some further service is required. Whether that service can be rendered by us as surgeons with a sufficient margin of safety is the question.

FIG. 263.—Loss of one eye.

AURICULAR FIBRILLATION.

Let us take one complication occurring in this disease—established (continuous, not paroxysmal) auricular fibrillation. Auricular fibrillation frequently has other causes, and when due to these other causes is scarcely remediable. Even in this disease I am unaware of its disappearing after it has become completely and permanently established before it was shown that an adequate operation could bring about this result. Read[22] writes : "At this point it should be mentioned that one of the chief aims in the management of this disease is to prevent myocardial damage, which leads to decompensation and is the one residuum of this disease which is most distressing and from which there is often no recovery." He continues : "It sometimes

happens that the patient will be found at the first examination already to have auricular fibrillation. The prognosis in such cases developing auricular fibrillation early in the course of the disease is unfavourable for recovery."

When discussing etiology I selected the heart as an organ suitable for indicating the effects of toxicity, because the effect on the heart can be observed and measured by the electrocardiograph. In dealing with the surgery of the disease the heart again gives us one of the clearest indications of the result of treatment. For long it was held, and I know is still not uncommonly believed, that when auricular fibrillation is present, especially when it is associated with a goitre which may have diminished in size, there must have been an antecedent history of rheumatic fever, arteriosclerosis, or syphilis, and that one or other of these conditions, and not the goitre, is responsible for the fibrillation. And it was longer still before it was realized that when these conditions had been established for months or years the irregular heart rhythm could be restored to normal, and that patients with widespread œdema could be restored to active life by surgical operation. This condition has been stated repeatedly to be a contra-indication to operation. I operated upon the first patient of this type in 1908 and found that this complication did not add to the danger of the operation.[23] I continued to operate upon patients of this type[24] only with the idea of improving their general condition, for this improvement was very definite, and then in six patients in whom fibrillation had become permanent, normal rhythm returned spontaneously. There still remained others who, although greatly improved, did not regain normal rhythm.

The next stage began through my association with Professor Fraser in the Professorial Units of St. Bartholomew's Hospital. Fraser had been especially interested in heart problems, and had become accustomed to the use of quinidine with its powers and limitations. The position now is that with combined medical and surgical treatment, many patients whose hearts have fibrillated permanently even for many years—some of whom have œdema extending to the upper part of the trunk, others of whom have been bedridden for months—have been restored to a health level with normal heart rhythm and free from œdema. Shortly after normal rhythm has been restored, quinidine, if it has been used, may be stopped. Normal rhythm cannot be attained for more than a short time by quinidine if an inadequate operation has been performed. I will refer briefly to three of these patients: one to show the length of history, one the degree of persistent œdema, and one the severe chest condition present.
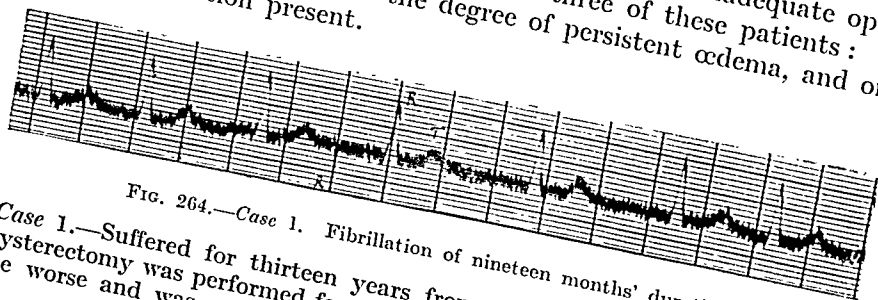
FIG. 264.—Case 1. Fibrillation of nineteen months' duration.

Case 1.—Suffered for thirteen years from goitre with palpitation. Ten years ago hysterectomy was performed for fibroids; immediately after this the palpitation became worse and was associated with great loss of weight and sweating. Eight

years ago the patient came to St. Bartholomew's Hospital, and has continued under medical treatment since. Nineteen months ago fibrillation began and has continued. Her electrocardiogram is shown in *Fig.* 264.
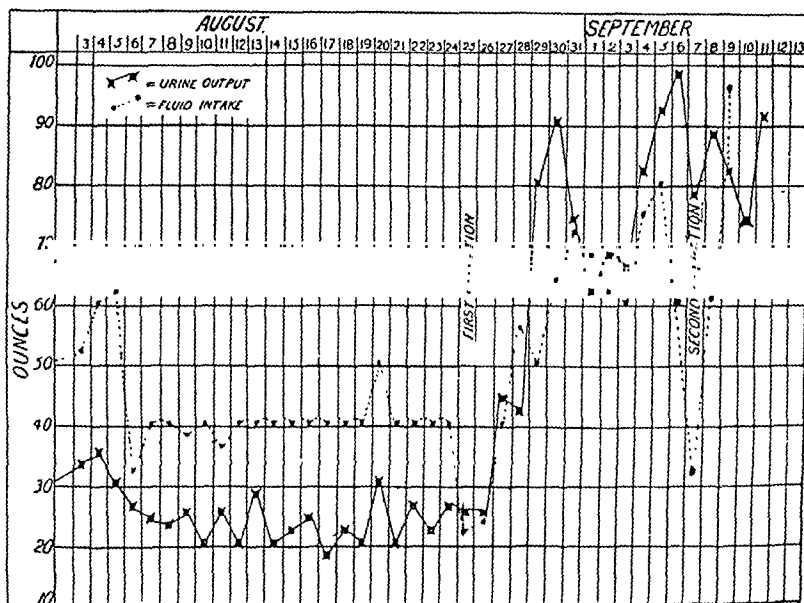
FIG. 265.—*Case* 2. Showing the output of urine for three weeks while under treatment with digitalis and diuretin, and the increase immediately following removal of part of the thyroid gland.

FIG. 266.—*Case* 3.

Case 2.—This patient had five years' continuous irregularity of heart rhythm with exophthalmos. She entered hospital with legs, thigh, and body œdematous; fluid in the abdominal and pleural cavities. The œdema of the thighs and the abdomen made it very difficult for her to be propped up in bed. The urine for three weeks was frequently down to one pint a day and never more than a few ounces above this. All known medical measures were used in hospital. The patient failed to respond and continued to lose ground. *Fig.* 265 shows the output of urine and the intake of fluid.

Case 3.—This man's bronchitis could not be brought under control even with long rest and treatment in the medical wards. It was partly dependent on his congestive heart failure. By ligating arteries one at a time, and subsequently dealing with each lobe on successive occasions, he was carried safely through. *Fig.* 266 shows his photograph and his electrocardiogram.
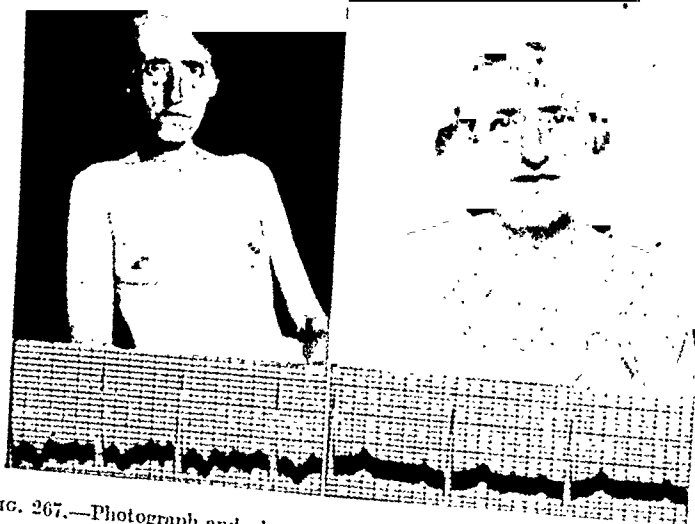
FIG. 267.—Photograph and electrocardiogram before and after operation.

a

b

FIG. 268.—*a*, Before operation ; *b*, After operation.

a

b
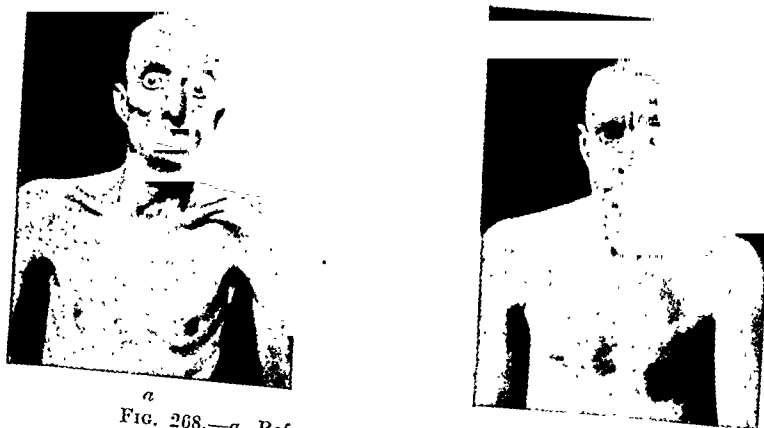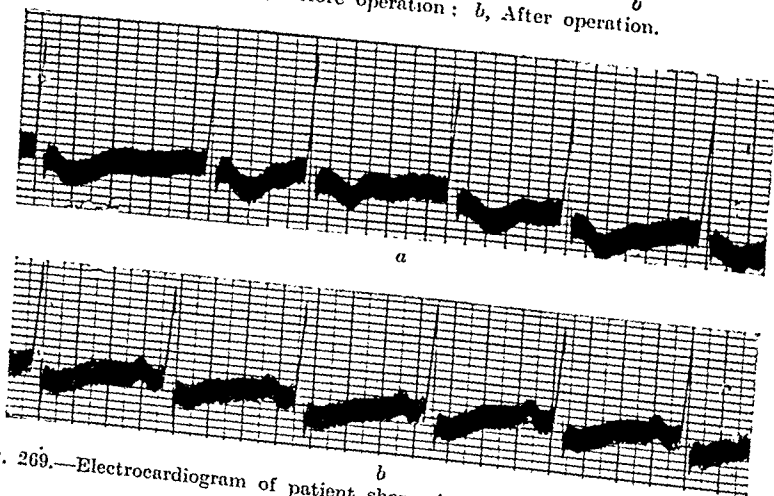
FIG. 269.—Electrocardiogram of patient shown in *Fig. 268*—*a*, before operation ; *b*, after operation.

I have taken a series of 100 consecutive patients with permanently established and continuous auricular fibrillation. I have not included those in whom *paroxysmal* fibrillation appeared to have become a permanent condition. *Figs.* 267, 268, 269, show electrocardiograms before and after operation, and photographs of the patients from whom these were obtained. It is interesting to see the decreasing pulse deficit following the second operation in a patient (*Fig.* 270). The first operation with subsequent medical treatment had failed to achieve this. Of these 100 patients regular rhythm has returned spontaneously in 48 after a sufficiently extensive operation. In 32 regular rhythm has returned after operation with the assistance of quinidine. Four felt so well after removal of one lobe that they were content to remain as they were; three of these four are living active lives; one died some years subsequently. In 7 who have had an adequate operation the heart has not yet returned to normal rhythm. Nine of the 100 have died following operation. This may seem to be high, but it should be remembered how very ill those who constitute this series were.* (The death-rate for partial thyroidectomy in toxic goitre when almost all risks are accepted is 2·7 per cent.) Should we not rather say that 81 per cent of people who were completely invalided have been almost completely cured, while 88 per cent are able to live lives very nearly normal? It would be idle to say that patients in this condition can be operated upon without risk, but the expectation of life in this class without operation is very low.

FIG. 270.—Decreasing pulse deficit following extirpation of an adequate amount of the second lobe.

Regarding the question of the permanency of the results obtained in this series of 100 patients, of the 81 in whom normal rhythm was restored, I believe only one has relapsed, and that was after six years of strenuous work, for this patient refused to limit her activities. It would be just as idle to state that these patients after operation have the physical reserves enjoyed by people who have not suffered from the disease. Almost all of them are living very active lives, and doing so with a degree of comfort which they had long ceased to expect.

Glycosuria and mental disturbance will be discussed on a subsequent occasion, but I must say something about exophthalmos.

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* In this respect Sir William Hale-White's[21] statistics should be remembered: Of 161 patients admitted to the medical wards of Guy's Hospital between 1888 and 1907, 18 died in hospital—just over 11 per cent. Undue weight should not be attached to these comparisons. Many patients in Hale-White's series would have been very ill on admission. Equally so were many in my series of fibrillators.

EXOPHTHALMOS.

It is frequently stated that this sign remains even when the other symptoms improve. It always becomes less if an adequate operation has been performed, but it may remain to some extent. The amount of improvement that may occur is shown in *Figs.* 271–275.

a *b*

FIG. 271.—*a*, 1925. Before operation. *b*, 1929. After operation.

FIG. 272.—*a*, 1926. Before operation. *b*, 1929. After operation.

FIG. 273.—*a*, 1922. Before operation.   *b*, 1926. After operation.

FIG. 274.—The left eye was lost owing to exophthalmos and ulceration. The left eye in the second picture is artificial.

FIG. 275.—The interval between these two pictures is only a few months. The exophthalmos, chemosis, and ulceration have disappeared. The œdema of the lower lids has not yet done so.

THE EXTENT OF THE OPERATION REQUIRED.

In order that we may give this service to patients the operation must be adequate, and it must be reasonably safe. Regarding the extent of the operation required, Halstead,[29] in an article on " The Parathyroid Glandules : their Blood-supply and their Preservation in Operations upon the Thyroid Gland ", states that the greater portion of both lobes may need to be removed in hypertrophy of the thyroid gland. Almost all the articles published in 1907–11 state that the extirpation of one lobe, together with the ligation of an artery of the opposite side, would cure 75 or 85 per cent of patients ; and this belief is still expressed in some modern books.[20] By the end of 1907 I knew that my experience did not bear this out, and in 1908 I wrote[23] stating that it was essential to remove a sufficient amount of the second lobe before a patient could be cured. I published this again in 1909,[24] in 1910,[25] and in 1912.[26] I do not find other reference to partial extirpation of both lobes until the paper by Halstead[27] published in 1913.

A less extensive operation, even the ligation of an artery, may give surprisingly good temporary results, but these results are almost never permanent, and if any one thing more than another brings the operation into disrepute (apart from operating in unsuitable cases), it is an inadequate operation. The patient, after being allowed to expect that she will be better, finds that fibrillation, exophthalmos, rapid heart, tremor, hot skin—all the distressing symptoms—remain, or return after she has undergone a severe ordeal. She will be disappointed and annoyed, and so will her doctor. Three patients were admitted last year, each having had two operations performed, each having been led to believe that everything that could be done had been done, and that no more was possible, two of them with fibrillation still remaining, and all unable to work. In each there was a mass remaining, inconspicuous because it was deeply situated, and in each, on removal of an adequate amount of this, normal rhythm returned spontaneously. We should not be induced to operate upon a patient unless we have her assurance that she will let us complete, in stages, what may be necessary.

The matter of incomplete cure raises another question. Some patients with toxic goitre have, apart from it, an unstable nervous temperament, neurasthenia, visceroptosis, or other conditions which would prevent them feeling well under any circumstances. Operation upon these patients requires careful consideration.

There is also a class of patients with symptoms resembling those of this disease to some extent, but not due to toxic goitre. These patients are thin, perspire freely, and have a rapid pulse-rate. The thyroid gland is not enlarged. They are not suitable for operation.

SAFETY OF OPERATION.

Regarding the safety of operation, and surgical management generally, I will say very little.

1. The death-rate of operation, taking all cases of toxic goitre, has been 2·7 per cent. If practically all risks are accepted, that is scarcely likely to be lowered.

2. In elderly people it makes a great difference whether the condition is primary or secondary. At this time of life the primary condition is rare compared to the secondary. The primary condition in an elderly patient is always a serious surgical risk. In the secondary condition the surgical risk is not as serious as would be expected from the signs and symptoms of the patient. It is to be remembered that whether primary or secondary the disease is essentially the same, but in the secondary type changes in the gland preceding the development of toxic symptoms have lessened the amount of active epithelium. There may be an extreme degree of cardiac decompensation, but the symptoms referable to the central nervous system are not so great, and it is the latter which give the danger to operation.

MANAGEMENT OF PATIENTS.

Iodine.—The surgeons of the world owe a great debt to Henry Plummer for his work in discovering the measure of safety that is given to the operation through the administration of iodine in suitable doses. It has helped so greatly that the literature would lead us to believe that the operation is now quite safe, that the necessity for ligation of arteries has passed, and that generally the complete procedure may be performed in one stage. To some extent this is true, but it is not completely true. Plummer[6] pointed this out. His statement is that 37 per cent improved markedly and promptly, 32 per cent definitely, 11 per cent only slightly—about equal to what would be achieved by hospitalization and rest—and 5 per cent were not affected. All accurate observation confirms this view. The patients constituting the 11 per cent, and especially the 5 per cent, still remain dangerous risks. Unless this is recognized and the operation graded accordingly, the death-rate will be unduly high. Again, without doubt in elderly patients iodine treatment sometimes gives a false impression of safety.

Special Cases.—In the old and very ill, and the young and very ill, it is wise to ligate vessels at a preliminary operation, and, even then, to remove one lobe first.

MORBIDITY FOLLOWING OPERATION.

Apart from the death-rate, the morbidity of operation must be taken into account. Injury to a recurrent laryngeal nerve is still a very present danger. I have had three severe cases of tetany in something over two thousand operations. This condition is very distressing. Two of these had had much X-ray treatment previously; the third had suffered from encephalitis lethargica. I simply record the facts. Halstead has shown that very occasionally the greater part of the parathyroid tissue may be situated within a lobe of the thyroid. I have once had a pulmonary infarct—non-fatal.

RADIOTHERAPY.

X-ray Treatment.—Regarding X-ray treatment I have to suspend judgement to some extent. I know that some patients with this disease are relieved by it, but cannot say just how many. Dr. Finzi and the writer are watching

some patients together. I know of four young women decidedly better, and one man in whom I am interested whose treatment was controlled by Dr. George Murray is back at work after several years' illness. In another, where not quite enough gland had been removed, X-ray treatment made an incomplete success into a complete one. I have no doubt that radiologists see some patients upon whom I have operated who have not been completely cured. On the other hand, since 1921 at least 31 patients have been sent to me for operation who had been given what had been regarded as adequate X-ray treatment, and were, when they came to me, without doubt very ill people— most of them gravely ill. The X-ray treatment had not been given casually in remote districts. It had in the main been given under skilled supervision and in big centres. These 31 include patients from the age of 17 to 60. Some had been at complete rest in hospital during the period of treatment; others had able practitioners outside and treatment under conditions of their own choice as long as was considered necessary.

Several of these improved while treatment was being given, but relapsed at once on cessation. With others the symptoms have been accentuated while under treatment, and many of the worst cases I have had with fibrillation and œdema had previously been treated by X rays. Burns still occur even under able supervision, and frequently the texture of the integuments has been so altered that when operation had to be performed healing was interfered with. I sometimes wonder whether the parathyroid glandules have their vitality lowered by X-ray treatment, for, as stated before, of the three patients who suffered from tetany subsequent to operation, two had received much X-ray treatment.

As a working rule I would suggest that X-ray treatment is inadvisable when

Fig. 276.—Damage to skin and deeper structures through injudicious X-ray treatment.

any of the graver complications are present, or in elderly patients where cardiac decompensation is present or imminent. In young patients without complications and where time is not of importance, it may be used; but, as with all medical treatment, the results should be watched and other measures adopted if it fails. Especially should care be taken not to damage the skin. I become rather prejudiced because of the condition many patients are in when they are sent to me, where I cannot help thinking that the treatment has been persisted in too long, to the detriment of the patient. *Fig.* 276 is not shown in any controversial spirit, but patients still come in this condition. The morbidity of X-ray and medical treatment should be borne in mind as well as that of surgical treatment.

Radium Treatment.—After X rays one naturally thinks of radium. I have had four patients who had been given radium treatment. Two of them

were sent to me by the practitioners who had administered the treatment. All four were very ill when I saw them. None of them had improved, and two of the four had become alarmingly worse under the treatment. Notwithstanding this, further experience may prove radium treatment to be of value.

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MULTIPLE POLYPOSIS OF THE COLON.

By JOHN H. ANDERSON and O. A. MARXER,

RUTHIN CASTLE, (NORTH WALES.

MULTIPLE polyposis of the colon has been described as far back as 1721, and as Sir William Wheeler[1] recently pointed out in this JOURNAL, is not so rare a condition as was at one time supposed. In 1924 J. E. Struthers[2] reviewed twenty cases of multiple polyposis in the alimentary canal, mostly in the colon. The difficulty lies in the diagnosis and, as the symptoms are those of ulcerative colitis, the sigmoidoscope and X rays offer the only means of recognizing the condition short of opening the abdomen and colon. Radiographs of polyposis are hard to come by, and the following cases are recorded mainly because in each the diagnosis was made by X rays as well as by the sigmoidoscope; they show also that when the diseased area is beyond the reach of the sigmoidoscope the diagnosis may be made by the X-ray picture alone.

CASE REPORTS.

Case 1.—A. B., male, age 61.

HISTORY.—One sister died from cancer of the rectum; another had ulcerative colitis and carcinoma of the cervix; one brother had ulcerative colitis. The patient had been constipated all his life. At the age of 38 he passed hæmorrhagic stools and suffered from loss of weight; the cæcum and part of the ascending colon were removed. At this time the pathologist reported that the bowel was enormously dilated with a thin atrophied wall. There was severe colitis again at the age of 57 and several mild attacks occurred later. In June, 1927 (three months before admission), the patient passed frequent stools containing mucus at first, and in August they became blood-stained. He gradually lost weight and appetite, and took no interest in his work.

ON ADMISSION.—He was admitted to Ruthin Castle in September, 1927, complaining of frequent colicky pains, with passage of flatus and liquid offensive stools, vomiting, thirst, loss of weight and strength.

ON EXAMINATION.—The patient was undernourished and too ill to weigh, but was found to be 7 stone 10 lb. two months after admission. His skin was irregularly pigmented, the temperature 100·5°, pulse 105, the tongue dry and furred, with desquamation of epithelium on the dorsal surface. His abdomen was distended and gurgling; there were general tenderness and spasms of pain every fifteen to twenty minutes. He passed seven to twelve motions in twenty-four hours, the stools being black, liquid, and offensive; they contained blood, pus, and mucus, but no parasites were found or pathogenic organisms on culture. The blood-count was as follows: Hæmoglobin, 85 per cent; red cells, 3,600,000; white cells, 3800 per c.mm.; on differential count immature forms were numerous (70 per cent); eosinophils, generally normal (1 per cent), on one occasion rose to 6·5 per cent.

X-ray Examination.—Owing to the patient's condition full examination by an opaque meal was not possible. A barium enema filled the colon readily, all parts being capable of dilatation except the rectosigmoid junction, which was narrow and ragged. The ascending and transverse colon were dilated, showed inhibition, and tended to expel contents too quickly. In the descending colon and sigmoid there

was a lack of segmentation, the outline was ragged, and nodular filling defects,
. . ˙ʰˑᵖˑˑ ˑ ˑ ¹ ˑˑ ᵥcomb appearance, were present throughout (*Fig.* 277).
˙ ˑ ˑˑ . (*E. I.* Spriggs).—Mucous membrane acutely inflamed, swollen
rugæ, passage narrowed at 13 cm. by a ring of polypi. One polyp was removed
which the pathologist reported to be a small polypoid fold of large bowel mucosa,
with engorged vessels supported by a fibro-inflammatory stroma, the gland tubules
being in a state of secretory over-activity.

DIAGNOSIS.—Ulcerative colitis with multiple polyposis of descending colon and
sigmoid.

This patient did well under prolonged treatment (four months) and was able
to resume work. In his case the polyposis seemed to be subsidiary to the ulcerative
colitis in the production of symptoms.
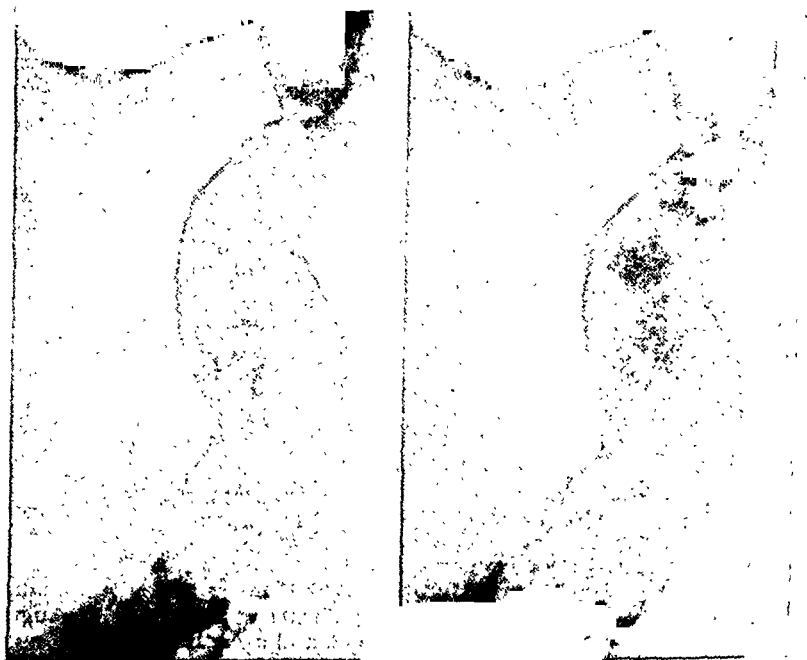
FIG. 277.—*Case* 1. Barium enema showing portion of sigmoid colon. The illustration
on the right was taken one second later than the one on the left.

Case 2.—C. D., female, age 34.

HISTORY.—The family history showed no cancer or colitis. At the age of 23
the patient suffered from constipation ; occasional bright blood with the stools,
and tenesmus ; the motions gradually became frequent, small, precipitate, and
finally were mainly blood and mucus. She steadily lost strength, grew anæmic,
and though the motions became larger they remained fluid. At the age of 29 she
was admitted to a nursing home with profound anæmia, colic, frequent blood-stained
stools, rapid pulse, and a temperature of 101°. The abdomen was opened in May,
1924, to perform an appendicostomy. The whole large bowel felt indurated and the
transverse colon was red on its peritoneal surface and œdematous. Irrigation
through the appendicostomy had to be stopped after a few weeks, as it was badly
borne, but the patient slowly improved and was ultimately able to get about again.
The next summer symptoms recurred with vomiting and pain severe enough to
require morphia ; this relapse was followed by slow improvement under treatment,
the motions, however, remaining frequent and precipitate. Three years later, in
August, 1928, symptoms again recurred, but did not yield to treatment.

On Admission.—The patient was admitted to Ruthin Castle in May, 1929, complaining of frequent motions, occasional vomiting, weakness, and breathlessness on any exertion.

On Examination.—The patient was well nourished and weighed 8 stone 4½ lb., her lips were colourless and her scleroties pearly. The pulse was 106, with frequent extrasystoles ; the abdomen full, showing no tenderness and good muscular tone : the spleen was palpable, and the appendicostomy patent. The motions varied from seven to fifteen in the twenty-four hours ; they were always precipitate and always contained blood, mucus, and pus ; there was occasional tenesmus ; the consistence varied from a large formed stool with streaks of darkish blood, to small motions, mainly clear or yellowish mucus, with specks of bright blood and faecal material ; non-haemolytic streptococci were the chief organisms recovered on culture. The blood-count was as follows : Haemoglobin, 28 per cent : red cells, 2,700,000 ;

Fig. 278.—*Case 2.* Barium meal showing colon eight hours after ingestion.

white cells, 5200 per cmm. ; the differential count showed numerous immature forms (23·6 per cent), and normal eosinophils (2 per cent).

On the clinical evidence a tentative diagnosis of ulcerative colitis was made, and, though polyposis was not thought of, the following atypical points were noted : (1) The condition of the colon as seen at the operation five years before ; (2) The patient's general nutrition and hearty appetite did not support long-standing colitis ; in addition, her appearance suggested that the anæmia was due to hæmorrhage from a clean rather than from an infected area ; (3) The skin of the abdomen had not the ' dead feel ' of the colitic patient, and the stools were often formed and almost normal except for streaks of blood.

X-ray Examination.—Barium meal : the stomach was empty in four hours ; the terminal ileum, the ascending and proximal part of the transverse colon were tender and expelled their contents more quickly than normal, barium reaching the

rectum within eight hours. The whole colon gave a honeycomb appearance with concave impressions on the margins (*Fig.* 278). This appearance was again seen with barium enema.

Sigmoidoscopy (E. I. Spriggs).—At about 6 cm. three small projections the size of a pea were seen, they were covered with mucous membrane and the tops were rounded ; a smaller one near by was like a short tail sticking up. At 13 cm. there was a small raised plaque, and just above this another projection about the size of a pea with three small convexities of the mucous membrane near it. (This appearance resembles that described and illustrated by Cuthbert Dukes.[3]) The instrument could not be passed beyond 16 cm. owing to a spasmodic contraction of the bowel. There was a slight redness of the mucous membrane, but the nodules had not the appearance of those round a cancerous stricture, and no ulceration was seen.

DIAGNOSIS.—Multiple polyposis of the colon with ulcerative colitis.

X-RAY TECHNIQUE AND APPEARANCES.

Unless the radiologist is warned of the presence of colitis, the polyposis may be missed, owing to the rapid passage of the meal through the colon. Frequent examinations are necessary, and the general routine of the ordinary barium meal may require considerable modification. The barium enema in *Case* 2 was given fifteen minutes after a hypodermic injection of morphia (gr. $\frac{1}{4}$) and atropi nesulphate (gr. $\frac{1}{100}$). The material was run in at low pressure (18 in.) with the foot of the couch raised and the patient prone. She was asked to lie as still as possible and especially to resist the inclination to empty the bowel. With these precautions adequate time was given to get good films.

In polyposis the filled bowel is studded with concave impressions on the otherwise smooth margin, and the mucosa in general presents a mottled or honeycomb appearance, probably due to only a thin coating of opaque material being present in parts, owing to displacement by the polypi. If the bowel is too distended to show this mottling, pressure with a wooden spoon or air-bag may produce it. Serial films showed some exaggeration of the lesser movements of the colon, but frequent incomplete mass movements were present with a slowing of the relaxation phase and absence of segmentation. The nodular filling defects at the margins of the filled bowel and the honey-comb appearance of the colon as a whole are the main features in excluding uncomplicated colitis.

Polypi of the colon are of two types, inflammatory and true tumours, the latter being more frequently met with. J. H. Saint[4] describes the inflam-matory polypi as " strips of mucous membrane which have become detached along almost their whole length, due to the undermining character of the ulceration." It is hard to imagine how structures of this nature can give the honeycomb appearance seen in *Figs.* 277 and 278. In fact it is uncertain whether inflammatory polypi can be diagnosed radiographically. In our opinion polypi of both types were present in *Case* 1, those seen in the lower bowel with the sigmoidoscope being inflammatory, and those shown in the descending colon and sigmoid by the X rays being true tumours. In *Case* 2 adenomatous tumours were demonstrated by both sigmoidoscope and X rays and there was no evidence regarding polypi of inflammatory origin. This

view is supported by the appearance of the mucous membrane adjoining the polypi; in *Case* 1 it was inflamed, but there was no evidence of disease in *Case* 2.

SUMMARY AND COMMENTS.

1. Two cases of multiple polyposis of the colon are described in which the diagnosis was made by X rays as well as by sigmoidoscopy. The radio-logical appearances and technique are described and discussed.

2. In one instance the accompanying colitis was acute (*Case* 1), in the other it was chronic with exacerbations (*Case* 2). In *Case* 1 other members of the family had suffered from ulcerative colitis, cancer of the rectum, and cancer of the cervix, thus agreeing with the experiences of D. H. Pennant[5] and J. P. Lockhart-Mummery.[6]

3. The general colitic nature of *Case* 1, especially the stools, is contrasted with the clinical picture given by *Case* 2, in which it is surmised that the polypi were of longer standing, and they were thought to be true tumours rather than merely inflammatory in origin.

4. Whilst the anæmia was greater in *Case* 2 the nutrition was better. It would appear that polyposis gives rise to less abdominal pain and interferes less with nutrition than colitis but is more liable to cause bleeding.

5. In each case constipation was an early symptom, if not the earliest.

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A REMARKABLE MECKEL'S DIVERTICULUM.

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THE literature on Meckel's diverticulum is already voluminous, but the unique size of the one described below and its unusual anatomical position appeared to me to justify record.

HISTORY.—Beatrice S., age 37, of Killamarsh, near Sheffield, was admitted to the Sheffield Royal Hospital on March 1, 1928 ; she died on March 14.

The patient was admitted on account of severe abdominal distension, dyspnœa, and abdominal colicky pain. She stated that the abdomen had always been big, and was sure that it had always been larger than it should have been. She always suffered from constipation, and this and the distension had always been much worse during pregnancy. During the previous three months there had been a further increase in the size of the abdomen accompanied by great difficulty in getting the bowels to work. She had had severe colicky pain every day for a month and had felt sick ; she had vomited a little during the week prior to admission. The bowels had only been opened every other day for a long time, and lately as many as five days had passed without a motion.

Recently the shortness of breath on exertion had become so bad that the patient had had great difficulty in walking up a hill and in performing the essential parts of her domestic work. She stated that the shortness of breath on exertion had troubled her for five or six years at least, and two years ago, when she was carrying her last child and was nearing term, it was exceptionally severe. She had had three children and there had always been severe trouble with distension of the abdomen during pregnancy, the patient thinking that she was pregnant with more than one child ; but this had never been the case. The abdomen had never gone down completely after confinements as she thought it should have done. She was sure that the abdomen had gradually got larger each year. She had been 'unwell' in November, 1927, but apart from a little bleeding towards the end of January, 1928, she had seen nothing since. There had been difficulty in starting to pass water, this having troubled her during each pregnancy; but when not pregnant there had been no trouble of this kind and no frequency. She did not suffer from a cough and had not lost weight, though she had been thin for the past fifteen years except 'in the belly'.

ON EXAMINATION.—The patient was a woman of thin type with a healthy complexion. There was no cyanosis or jaundice, and examination of the mouth was negative apart from some defective teeth. As she lay in bed she appeared to be comfortable when propped up, but when placed in the recumbent position she had difficulty in breathing. No adventitious

sounds could be heard in the chest, and the heart appeared to be free from abnormality.

The abdomen was enormously, uniformly distended, and through the thin, taut parietes peristalsis of small intestine type could be plainly seen. There was no evidence of any free fluid. To percussion the left half of the abdomen was hyper-resonant, whereas it was noted to be dull on the right. A lump could be felt in the hypogastric and left iliac regions rising out of the pelvis and with a rounded upper end. It did not disappear after catheterization and was apparently a uterine swelling. This was not dull to percussion. Examination of the abdomen was extremely difficult on account of the marked distension. No tenderness was present and no fluid thrill elicited.

Mr. J. Chisholm very kindly examined the woman for me and his report on the pelvic swelling was as follows :—

"The patient's history of amenorrhœa varies slightly from the history she has given to you. She says she was unwell in November and also in December and bled for one day on Jan. 7. There is a curious rounded swelling rising above Poupart's ligament on the left side with some slight resistance to the right of this. The cervix uteri is softened and cyanosed. I think the swelling is an enlarged, misplaced uterus—size (?) 4 months, not tender or fixed. Nil felt extra-uterine. Examination is not easy."

No secretion could be obtained on squeezing the breasts. Rectal examination, after several enemata had been given, proved negative.

The woman was plainly suffering from chronic intestinal obstruction and was probably about three or four months pregnant. Whatever the cause of the obstruction, it was evident from the patient's clear history that the marked abdominal distension had not suddenly appeared but had slowly been increasing for years. The distension had become so severe two years ago that by the time she reached the end of pregnancy severe symptoms had resulted from pressure on the diaphragm. Now, at the period of three months, she had already symptoms referable to pressure on the diaphragm and bladder. It was extremely difficult to make a diagnosis of the cause of the distension and the associated chronic small intestinal obstruction. It was considered most probable that there had been a tuberculous peritonitis with a loculated collection of fluid on the right side. If this was correct, then the obstructive symptoms presumably were the result of adhesions. The uterus had been by some means displaced to the left side of the pelvis.

The patient was given extra fluids for a week by proctolysis and hypodermoclysis. Glucose was added to the rectal salines. (She had been afraid to take food freely for the past three months, as she was sure that this caused the abdominal pain.) A barium meal examination was not made, as it did not appear at the time that it would be likely to throw further light on the case. In view of the operative findings I regret that this was not done.

OPERATION (March 7, 1928).—The abdomen was opened by a paramedian incision from the umbilicus to the pubis. The wound had been first infiltrated by novocain, and when the abdomen was opened ether was given. The hand passed into the pelvis immediately found a pregnant uterus of three to four months' gestation. The coils of small intestine were slightly distended, but

not so markedly as one had expected to find them. The hand then encountered a large tumour extending from the right iliac fossa to the liver above and filling the whole right half of the abdomen. Its lower end was in contact with the enlarged uterus, but between them—on the right side of the uterus—descended the sigmoid colon. The liver appeared to be displaced over towards the left side of the upper abdomen. The huge mass was covered by peritoneum on the anterior surface and on the right side; here the peritoneum became reflected on the parietes. On the left side the omentum was adherent to and obscured this surface. The posterior surface was lying directly upon the posterior abdominal wall. The upper end of the tumour was rounded and so firmly pressed against the liver that the hand could not be inserted between them. The liver was decidedly elevated by the swelling. The tumour wall was typical of an enormously distended piece of bowel. It contained material of putty-like consistency, since it pitted on pressure of the
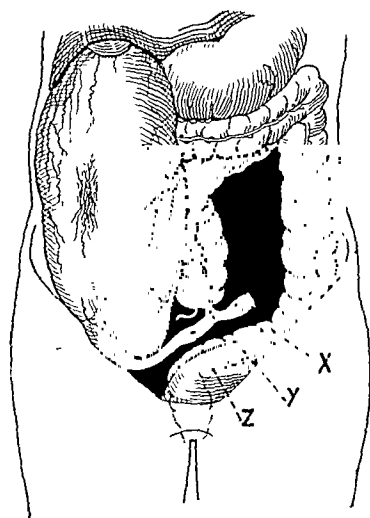
FIG. 279.—Findings at operation.

finger and these dinted pressure areas showed no tendency to fill out when the pressure had been removed. The cæcum was lying to the left side of the lower end of the tumour with the ascending colon running vertically upwards in the mid-line of the body (*Fig.* 279). The lower end of the distended pouch of bowel narrowed somewhat and overlapped the right pelvic brim. Here it became continuous with a coil of intestine which ran straight into the hypertrophied and slightly distended last coil of the ileum. The ileum also communicated with the cæcum. The terminal two inches (it seemed no longer than this as the condition was seen at operation) of the ileum communicated with this portion of small gut as shown in *Fig.* 279. The ileum appeared to run almost directly into the lower end of the pouch, and a short piece of bowel, leaving this at an angle, entered the cæcum. It was plain that the ileum ran from X to Y and so through the ileocæcal valve into the cæcum, but the communication Z with the huge pouch had caused an angulation at the junction of X and Y. The lower end of the pouch appeared to have a longitudinal band on its anterior surface which gradually disappeared as it ascended the pouch. This gave the lower end of the pouch a close resemblance to large gut.

It was not easy to make out the exact state of affairs in this region between the enlarged uterus in the pelvis and lower end of this enormously distended piece of bowel. Neither Mr. Chisholm (who very kindly assisted) nor I had knowledge of such a condition having been encountered before. Removal of the huge sac, firmly adherent posteriorly, was clearly out of the question. We both felt it was most likely to be an enormous Meckel's diverticulum, but its size, position, fixation, solid fæcal contents free from flatus, and its communication with the ileum, apparently within a couple of inches

of the ileocæcal valve, appeared to us peculiar. The semblance of a longitudinal band also added to the confusion.

The patient was taking the anæsthetic very badly and breathing was very laboured. It was plain that above all an attempt had to be made to drain the huge fæces-laden sac. The sigmoid was adjacent to the lower end
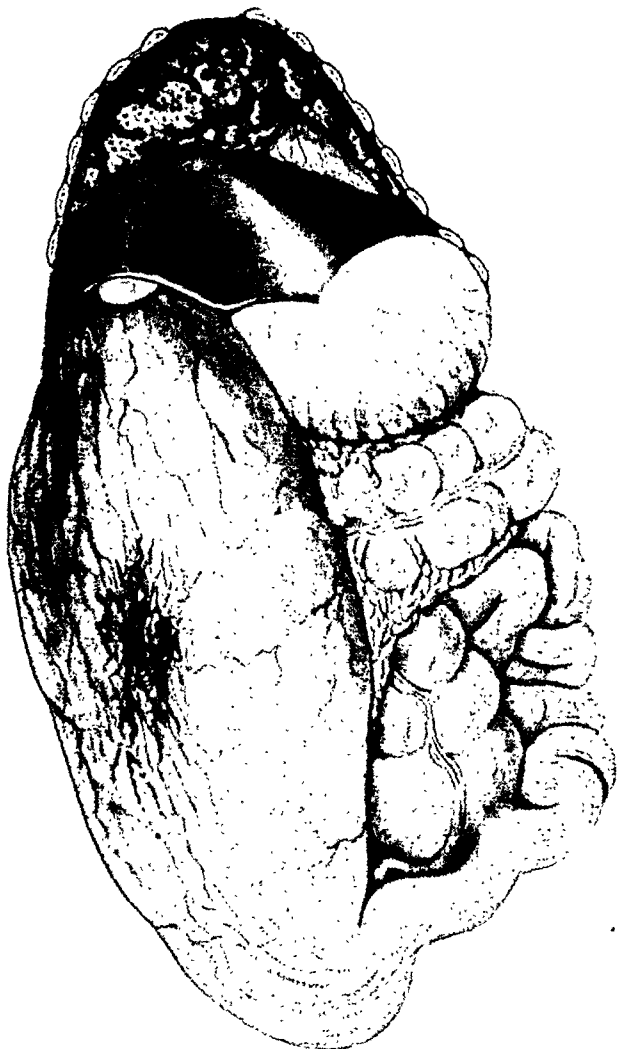
FIG. 280.—Drawing of the diverticulum made at autopsy. It clearly shows the large size of the pouch, the small thoracic capacity, and the mode of termination of the ileum.

of the sac and this was laterally anastomosed (with no little difficulty) to the lower end of the sac and a rectal tube passed up to the anastomosis from the anus. The abdomen was closed and the patient returned to bed. We now felt sure that the sac must be an unusually large Meckel's diverticulum, the contents of which must have been slowly accumulating for years.

SUBSEQUENT PROGRESS.—The progress after operation was as follows :—

March 8.—The pulse was thin but only 84. Propped up in bed the patient looked comfortable, but breathing was more difficult than before the operation. Temperature 98°.

March 9.—She was much the same. The abdominal distension did not appear, however, to be any less, and there had been no improvement in the breathing. Temperature 98°, pulse 100.

March 12.—The wound was clean and the clips were removed. She was, however, weaker. There had been no vomiting since the morning following operation. She had a slight cough and laboured breathing. Temperature 98·2°, pulse 112, respiration 30.

March 13.— In the evening she aborted and was delivered of a four-months fœtus. Previously the bowels had been opened and flatus freely passed. After the abortion the pulse became much faster, 136, and she rapidly worsened.

March 14. — She remained extremely ill without responding to the usual stimulating measures (including blood transfusion), and died in the early hours of March 15, the eighth post-operative day.

POST-MORTEM FINDINGS. — The coloured drawing (Fig. 280) most clearly depicts the state of affairs met with at the autopsy; it is reproduced from a drawing which Miss E. M. Wright made in the post-mortem room. When this was done the parts had not been disturbed (beyond bringing the ileo-cæcal region to the surface in order the more clearly to depict the anatomical arrangement in this area). The painting shows the size of the Meckel's. diverticulum (the omentum adherent to its left side had been separated and cut away) and how it had by gradual growth displaced the abdominal organs into the left half of the abdominal cavity. The extreme elevation of the diaphragm makes the thoracic capacity
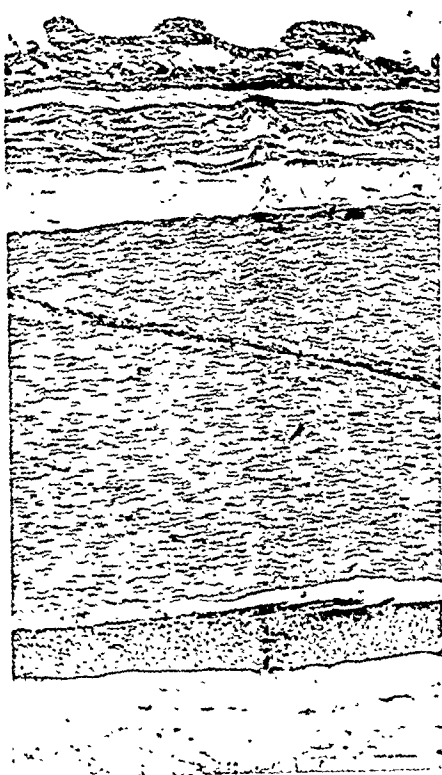
FIG. 281.—Transverse section of wall of diverticulum.

extremely small compared with the size of the abdominal cavity. It is at once obvious that the pulmonary vital capacity must have been very small indeed and the action of both the lungs and the heart seriously encumbered. There was no peritonitis around the sigmoid anastomosis to the diverticulum (not depicted). The lungs were markedly congested. So far as I could make out the anastomosis had failed to produce any evacuation of the contents of the diverticulum. The diverticulum was firmly fixed over

its entire extent to the back of the abdominal cavity, and in removing it I had to cut its posterior adhesions with a scalpel. There was no evidence of any persisting peritoneum posteriorly. The pouch was filled by solid fæcal material and no gas or fluid material was present. Its communication with the ileum was firmly ligatured and the diverticulum after removal was found to weigh *six pounds four ounces.* Death appeared to have been due to post-operative pulmonary congestion producing syncope. The abortion was an additional factor.

The specimen was sent to the Sheffield University Pathological Department ; Dr. H. W. Gleave has carefully examined it and given me the following report and microphotograph (*Fig* 281) :—

Specimen received March 16, 1928. At a distance of 8 cm. above the ileocæcal valve the ileum shows an acute kink, and from the antimesenteric border a huge diverticulum is given off. Proximally this is of the same diameter as the ileum, but it enlarges at first gradually and then abruptly into a large pouch as seen in the sketch. The length of the diverticulum is 56 cm., the greatest diameter 17 cm., the circumference 50 cm. The upper end is blunt and closed. There is a smooth peritoneal coat except posteriorly, where there is a mesentery carrying blood-vessels and containing fatty tissue. There is also a small amount of fat visible beneath the peritoneum of the diverticulum. Near the lower end a lateral anastomosis to the sigmoid colon has been made. The contents consist of brown fæces of the consistency of putty. The inner aspect shows a smooth mucous membrane with no local thickenings. There is no valve at the junction of the diverticulum and ileum.

Microscopically, sections from various parts show the structure of a Meckel's diverticulum. There is a low mucous membrane with glands, resembling that of the small intestine, a muscularis mucosæ, and circular and longitudinal muscle coats. Except for great hypertrophy of the muscle, especially the circular muscle, the appearance exactly corresponds with that of a Meckel's diverticulum 12 cm. long from the Museum. Scanty lymphoid tissue is present in the mucosa. No nodules of pancreatic tissue are seen. A comparison with sections of the wall of the ileum shows that both muscular coats of the diverticulum are in general about five times the thickness of those of the ileum. (The specimen was fixed by distension in formol saline.) The only pathological feature found is in the mucosa, where the blood-vessels are engorged and there is a small amount of lymphocytic infiltration.

COMMENTS.

In a survey of the available literature I have been unable to find any description of a Meckel's diverticulum of such dimensions as the one described above. Philip Turner[1] in 1906 collected 360 cases of Meckel's diverticulum, but not one was of large size. They conformed to the well-known varieties. Bilton Pollard[2] describes a Meckel's diverticulum of remarkable length, 36 in., but it had roughly the same diameter as the ileum from which it arose, and fell into the group of cases formerly recorded under the heading of 'duplication of the intestine'. It is possible that a case similar to the one I have here recorded has been described before, but if so, I have failed to find it in the voluminous literature which has been written on this interesting congenital abnormality. Several writers on this subject have described instances of Meckel's diverticula possessing club-shaped ends (e.g., Klemp). J. Playfair McMurrich and F. F. Tidesdale[3] describe a diverticulum arising from the terminal ileum at its mesenteric attachment and ending in the region of the hepatic flexure of the colon in a bulbous-ended expansion 10 by 6 cm. in

diameter. The proximal tubal part, however. is of the same diameter as the ileum and 104 cm. in length. In discussing the formation of the unusual types of Meckel's diverticulum, the writers make the suggestion that they may represent the entire yolk sac. They suggest that when the primary loop of the intestine returns to the abdominal cavity during the early period of embryological development it may, in very rare instances, drag with it the vitelline duct and the entire yolk sac. It may be that this is the explanation of the origin of the large diverticulum I have described above—in other words, the diverticulum may be the entire yolk sac.

Neither pancreatic tissue nor gastric mucosa was found in the areas of the wall examined by Dr. Gleave. This may be due to the fact that these, if present at all, were in portions of the wall not microscopically examined. According to Schartz,[4] pancreatic tissue is found in only 10 per cent and gastric mucosa in 16 per cent of cases examined carefully.

If I should ever meet such a case again—which is unlikely—I feel that the best treatment would be to divide the communication between the diverticulum and the terminal ileum and drain the sac through a stab-opening in the loin posteriorly. The drainage even then would be slow and would probably need the help of lavage. A permanent mucous fistula might ensue, but I do not consider that any form of internal drainage by anastomosis would drain effectively a Meckel's diverticulum of this type.

I wish to express my sincere thanks to Dr. Gleave for his pathological report on the specimen and for the microphotograph ; to Mr. Chisholm for his kindly help ; and to Miss E. M. Wright for the excellent painting.

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STRANGULATED INTERNAL HERNIA
IN A RETRO-APPENDICULAR PARACÆCAL POUCH.

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MUCH discussion has taken place over the various pericæcal peritoneal fossæ and their development, and even more over the question of their liability to cause strangulation of gut. Most interest centres on the ileo-appendicular pouch (the inferior ileocæcal of Treves and others), as it is difficult to conceive how such a small fossa could snare gut—the ileocolic is always too small to do so and is only of anatomical interest; and while there are authentic cases recorded by Nasse[1] and Riese[2] of strangulation of short portions, other cases in which large loops have been reported as incarcerated seem less possible.

The case to be recorded discloses another pouch in the same location formed by lack of fusion between the mesocolon and the posterior parietal peritoneum in the terminal stage of embryological rotation of the intestine. Its size and its capability of becoming larger by distension from within, possibly throw some light on these large herniæ which, without the advantage of a post-mortem dissection, have been termed ileo-appendicular. I can find no previous description of this fossa. An additional interest is to be noted in the presence of a 'retroperitoneal' position of the vermiform appendix.

CASE REPORT.

A man, age 57, was admitted to the London Hospital in September . . . 1928, with a history of four days' abdominal pain originating in the . . . . but shifting later to the right iliac fossa. Vomiting, at first bilious and then stercoraceous, was frequent. An accurate history of bowel movements was not procured.

ON EXAMINATION.—The patient was . . . . . the pulse 140, and the temperature 100·5°. The abdomen was . . . . , with no rigidity except in the right iliac fossa, where moderate resistance was accompanied by some deep tenderness and an indefinite lump was palpable. A diagnosis of acute obstruction of the small intestine was made.

OPERATION.—At operation congested and moderately distended small intestine was traced to an opening behind the ileocæcal junction, where both entering and leaving loops could be detected. The lower small intestine, cæcum, and large gut were collapsed. Fully a foot of small intestine was easily withdrawn from the opening and was found to be moderately congested and dilated, with well-marked constriction rings at either end. The loop quickly regained its colour and the constriction rings also seemed capable of spontaneous recovery. The operation was then finished as quickly as possible. The patient died two hours later.

POST-MORTEM FINDINGS (*Figs.* 282, 283).—The hernial pouch, measuring 10 by 9 cm. in the collapsed state, lies to the inner side of the ascending colon just above the ileocæcal junction and external to the line of attachment of the mesentery proper. The anterior wall of the sac is transparently thin and vascular and has fused to it posteriorly the appendix, which points spleenwards. The ascending colon, although
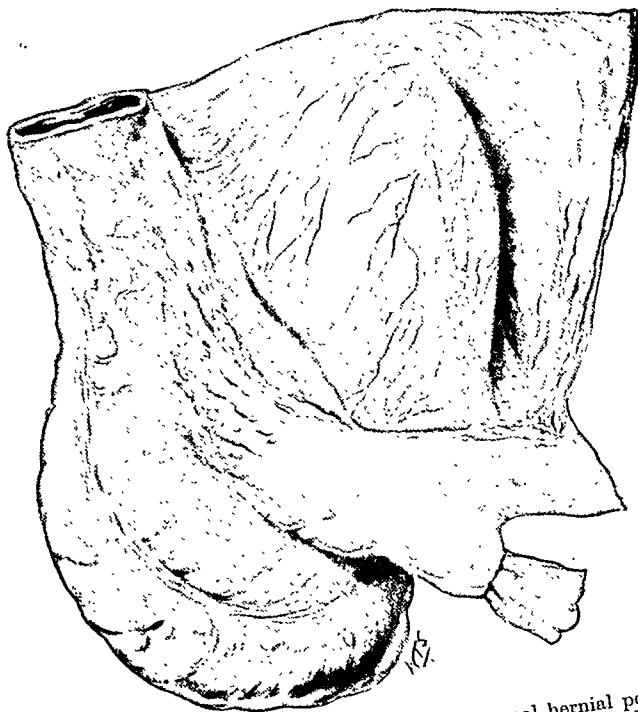
FIG. 282.—Post-mortem specimen showing the internal hernial pouch which has been distended with cotton-wool introduced through the opening seen in *Fig. 283*. The tip of the appendix can be detected showing through the anterior wall. The specimen has been spread out and the attachment of the mesentery proper does not show, being further to the left.
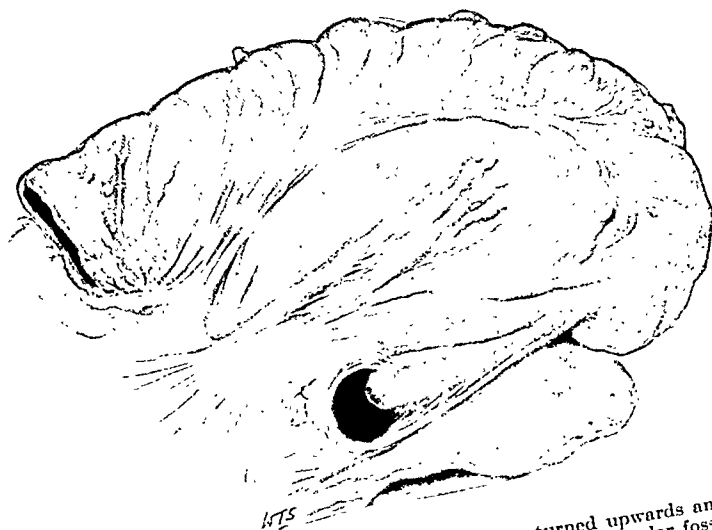
FIG. 283.—The cæcum and terminal ileum have been turned upwards and to the left to display the entrance to the sac. The opening of the ileo-appendicular fossa proper can be seen as the more darkly shaded part below it.

fixed by its inner border so that the pouch never becomes retrocolic, is otherwise free posteriorly, allowing colon and cæcum to be turned upwards and to the left, as in *Fig.* 283, to disclose the hernial opening. The opening (1·5 cm. in diameter) has for its anterior margin a straight fold passing from the cæcum at the base of the appendix to the parietal peritoneum of the iliac fossa. The posterior margin is a crescentic fold attached below to the anterior fold and above to the appendix about two inches from its base.

An ileo-appendicular fossa admitting two fingers is also present, the ileo-appendicular fold running from the terminal two inches of ileum to the appendix itself in so far as that process is outside the sac (*see Fig.* 283), and then losing itself on the anterior margin of the hernial opening. This fossa is funnel-shaped with a wide entrance, and the walls are overladen with fat of little strength.

Further dissection shows that the posterior wall of the sac supports only a few fine vessels, being relatively avascular compared with the anterior wall.

The loop of intestine which had formed the sac contents was found to be sixteen inches long and derived from the ileum about five feet above the ileocæcal valve. It was marked at one end by a distinct and at the other by a rather indistinct anæmic constriction, and showed ill-defined areas of hæmorrhage with some fibrinous peritonitis. There was collapse of intestine below this and distension above.

COMMENTS.

The paracæcal peritoneal fossæ described by Lord Moynihan[3] in his classical work on retroperitoneal hernia are the ileocolic and ileo-appendicular fossæ (the superior and inferior ileocæcal fossæ of Treves and others), the retrocæcal fossa, the fossa of Hartmann, and the fossa iliaco-subfascialis. Rendle Short,[4] in collecting cases subsequently reported, has described another form with the opening on the outer side and the fossa behind the cæcum. Neither mentions the fossa here discussed. The most similar description is Lockwood and Rolleston's[5] previous description of an ileocæcal fossa which they found frequently situated behind the angle of junction of ileum and cæcum, running for a varying distance upwards behind the ileocolic junction and parallel to the ascending colon. So far the description tallies, but then they go on to give its right boundary as the mesentery of the ascending colon and its left as the mesentery proper, and say that it is frequently complicated by two folds, the mesentery of the appendix and the ileocæcal fold. It is obvious therefore that they were describing a larger form of the ileo-appendicular fossa, and thus Lord Moynihan has grouped their ileocæcal fossa as such.

The genesis of the fossa here described is apparently failure of fusion of the ascending mesocolon with the parietal peritoneum in the terminal stage of rotation of the gut. Its formation is therefore similar to that of an inter-sigmoid fossa on the left side. According to Frazer and Robbins[6] fixation of the mesocolon, in a general way, spreads peripherally. In this instance it has been interrupted, probably by the position of the appendix. It is likely then that the hernial opening was kept patent by the pull of a cæcum always changing in volume and that this stress has also given rise to the firmness of its margins. The interrupted process is much less common than the state in which fixation stops short, the latter leading to the terminal ileum and ascending colon being on a common mesentery and thereby predisposed to volvulus.

Stich[7] has described a strangulated hernia in the ileo-appendicular fossa in which two metres of gut were implicated. The diagram he gives from his

impressions at operation reveals a pouch in the same position as the one just recorded, only larger, which he describes as lying in a cavity somewhat above the cæcum between the vermiform process and the ileocæcal junction. It would seem very unlikely that an ileo-appendicular fossa should dilate to such a capacity, and although the appendix in his case was not within the sac there is no reason why failure of peritoneal fusion should not be the more probable cause of such a large pouch.

The case also furnishes an example of a 'retroperitoneal' appendix, and it is interesting to speculate on the ready-made limitation of any effusion should acute appendicitis ever have occurred, which advantage might have been counterbalanced by the difficulty of finding the offending organ.

SUMMARY.

A retroperitoneal fossa lying in the ileocolic angle is described. It is distinct from the ileo-appendicular fossa, which is also present. It contains the appendix adherent to its anterior wall and at operation also contained sixteen inches of strangulated small intestine. Its probable origin is the result of interruption of fusion between the ascending mesocolon and the posterior parietal peritoneum in the last stage of embryonic rotation of the mid-gut.

It is suggested that the larger retroperitoneal herniæ of this region may have been previously wrongly ascribed to the ileo-appendicular fossa whilst actually occurring into the one described.

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[4] RENDLE SHORT, *Brit. Jour. Surg.*, 1915, iii, 48 ; 1925, xii, 456.
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LATENT GAS GANGRENE INFECTION.

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THE following cases are considered worthy of record, not only in view of their rarity, but also because of the prolonged and interesting histories, with peculiar clinical findings, and the ultimate onset of acute gas gangrene many years after the receipt of the original wound. All the patients were wounded soldiers, and the histories have been obtained from their medical record cards.

Case 1.—F. E. C., admitted on June 13, 1926, sustained a shrapnel wound of the right tarsus in September, 1917. The metal was removed and the wound cleaned by operation, but a sinus persisted. Operations in April and October, 1918, for the removal of necrosed bone failed to promote healing, and in May, 1919, a Syme's amputation was performed. The wound, after healing by first intention, broke down, and this ulceration healed and recurred so persistently that the wearing of an artificial limb was impossible. In March, 1920, the limb was amputated below the knee. From that time the patient had continual pains in the 'phantom' limb, with occasional cramp-like pains in the thigh. To relieve the pains he had had four operations for the removal of neuromata and shortening of nerves in the stump, and on each occasion, after apparently healing by first intention, the wounds broke down in part, and although there was very little discharge they took one to two months to heal. From 1921 an artificial limb had been worn at intervals with discomfort; on two occasions ulceration over the head of the fibula occurred, probably owing to pressure by the artificial limb.

ON ADMISSION.—The patient complained of pains referred to the ankle, with sensation of clawing of the toes, and occasional cramp-like pains in the thigh. He had not worn an artificial limb for four months.

ON EXAMINATION.—The right leg had been amputated below the knee—stump 7½ in.; amputation and other operation scars were well healed, painless, and not adherent; the head of the fibula was very prominent, and a small scar on the outer side showed evidence of recent ulceration. A definite tender neuroma of the internal saphenous nerve was present about four inches below the knee-joint, and one on the external popliteal nerve behind the tendon of the biceps. Although he complained of pains in the thigh, he could not point to a definite site, nor was there any single tender spot. The groin glands were not enlarged. Clinically and radiographically the spine and pelvis, the sacro-iliac, hip-, and knee-joints were normal, and there was no evidence of any bone disease in the thigh or stump. The central nervous system was normal, the Wassermann reaction negative, and the urine free from albumin and sugar.

OPERATION (Sept. 1, 1926).—After allowing complete subsidence of inflammation over the head of the fibula, operation was performed, the prominent part of the head of the fibula being chiselled away ; the neuroma on the internal saphenous nerve was removed and the nerve avulsed. The external and internal popliteal nerves were dissected up to their separation from the great sciatic about four inches above the knee, and divided. All wounds healed by first intention.

SUBSEQUENT HISTORY.—Three weeks later the patient again complained of pains in the popliteal space and also referred to the foot. On commencing to wear an artificial limb considerable swelling occurred in the popliteal space, or more particularly that area between the upper limit of the bucket and the lower margin of the thigh corset of the artificial limb. This swelling was peculiar ; there was no inflammation or tenderness, it was not brawny, nor did it pit like an ordinary œdema. The sensation was rather like that of palpating the fairly well distended bladder of a football. It occurred after wearing a limb about half an hour, and persisted till the artificial limb was left off, when it gradually dispersed.

On Nov. 9, 1926, that is, about two months after the operation, the wound in the popliteal space broke down, and although there was no discharge the sinus persisted for about two weeks.

SECOND OPERATION (Dec. 4, 1926).—In view of the persistence of the pain, a further operation was performed. The scar in the popliteal space was excised, but apart from a few thrombotic veins, which were removed, nothing to account for the pain could be found. This wound healed by first intention, but, as on the previous occasion, pain and swelling again recurred on commencing to wear the artificial limb. A period of complete rest for four weeks was given, but without producing any alteration in the condition. Amputation above the knee was therefore advised, and the operation performed on March 5, 1927, the limb being amputated at mid-thigh. At the operation the muscles in the posterior flap were noticed to be of a peculiar blue-grey colour.

Apart from slight pain in the stump, the patient was quite well for two days, and on the morning of March 7 the stump was examined, appeared to be satisfactory, and there being practically no discharge the drainage tube was removed. In the evening, however, the patient complained of increasing pain in the stump and also in the right iliac fossa. The temperature was 99·2° and the pulse 106. Examination of the stump showed it to be swollen and discoloured, and definite crackling was present which also extended to the abdominal wall over the right lower quadrant. The stump was opened up and much gas escaped. Free incisions were made into the crackling areas in the abdominal wall, but the patient's condition rapidly deteriorated, a typical text-book description of gas gangrene ensuing. He died at 3 a.m. on March 8.

A complete section of the tissues of the thigh, from skin to bone, was removed immediately after death and sent for examination.

PATHOLOGICAL REPORT.—" The sections show thickening and narrowing of arterial vessels with fibrotic change marked in the middle coat—in one vessel a very early organizing thrombosis can be seen. A large nerve-trunk

shows a marked intra- and interstitial destruction of many nerve-fibres. Muscle shows no change therein at certain areas, while at others there are varying degrees of degeneration to complete loss of histological structure. A separation of tissue elements at such degenerated areas with what are probably gas bubbles is also seen. This condition seen in the muscle is due to the proliferation and extension of a Gram-positive short and medium length bacillus in which spores are not seen—later proved to be *B. aerogenes capsulatus.*

" Cultures show the presence of two Gram-positive bacilli that produce spores : (1) A strict anaerobe *B. aerogenes capsulatus,* (2) *B. mycoides,* which grows aerobically and anaerobically. Whether the latter was present within the tissues is not certain."

Case 2.—A. H. J., admitted on July 8, 1927, received a gunshot wound of the right arm in September, 1917. Two days later operation was performed for excision of the wound and removal of metal. Ever since he was wounded the patient had had pains in the arm of a vague cramp-like character. In 1920 he had a sudden onset of diffuse swelling of the arm which was diagnosed as an internal hæmorrhage. Since that time he had had many similar attacks, the extent of the swelling varying, and frequently being produced by only a slight flexion of the elbow. The condition had been diagnosed as myositis ossificans, and the patient was given a leather support encasing the whole arm from the shoulder to wrist and fixing the elbow. He had had the following operations :—

1923.—Large spur of bone removed from the humerus ; the muscle tissue was fibrotic ; microscopic examination confirmed this and also calcareous deposits.

August, 1926.—Medulla of the humerus opened ; no pus found.

April, 1927.—Vessels in the arm explored ; found normal ; periostitis present.

June, 1927.—Two spurs of bone projecting into the triceps removed.

Having just left hospital in Leeds after this last operation, the patient was travelling by train to London, when the arm suddenly commenced to swell. He left the train at Birmingham and was admitted to the Highbury Hospital. He complained of severe pain in the upper arm, and numbness and tingling of the hand and fingers.

On Examination.—There was diffuse swelling of the right upper arm, extending a short way below the elbow ; general tenderness, but no single maximum point. There was no discoloration suggesting hæmorrhage, and the swelling did not pit as an ordinary œdema. Wrist, finger, and shoulder movements were complete. Temperature 99·2°, pulse 88. Nothing abnormal was discovered in the heart or lungs ; the blood-pressure was—systolic 138, diastolic 78 ; coagulation time, normal. The central nervous system was normal ; Wassermann reaction negative. X rays showed thickening of the middle third of the humerus with some rarefaction and slight periosteal irregularity on the anterior surface, with two small opaque nodules in the area of the biceps, suggesting calcified or bony spicules.

Subsequent History.—The arm was slung up vertically and a firm

bandage applied. The swelling gradually subsided, and at the end of a week the arm was practically normal; no discoloration suggesting hæmorrhage occurred.

OPERATION (July 20, 1927).—The humerus was exposed by incisions on the outer and inner aspects. All bony irregularities were removed from the shaft, restoring its normal cylindrical shape. An opening was trephined into the medullary cavity at the site of rarefaction suggested on X-ray examination, but no pus or granulation tissue was found. The biceps muscle appeared fibrotic, particularly in its upper outer aspect, and the anterior three-quarters of the muscle was removed. The brachial artery was examined and found to be occluded in its lower half. Small drains were provided in each wound. The removed portion of the biceps muscle was sent for examination.

Next day the patient's condition was satisfactory, the temperature 99·8° and the pulse 88. Some swelling of the forearm and hand was present, and the circulation was rather sluggish. The following day the patient's condition remained the same; there was considerable discharge of a dark grumous material from both wounds.

On July 23 the patient's condition was deteriorating, the temperature being 100·2° and the pulse 100. There was diffuse swelling of the limb, the skin of the upper arm was discoloured, and there was a profuse discharge of gas bubbles with grumous material from the wounds.

SECOND OPERATION (July 23, 1927).—Under gas and oxygen anæsthesia the arm was disarticulated at the shoulder and the incision continued to the lateral wall of the chest through the crepitant area, and carried through the serratus magnus and latissimus dorsi muscles, which were of a dark grey colour in part. The deeper muscles of the chest wall appeared normal. The extensive wound was left open and packed with gauze soaked in saturated solution of magnesium sulphate. A section of the tissues from the arm was sent for examination.

The patient was given 40 c.c. of anti-gas-gangrene serum and salines intravenously. Further injections of 40 c.c. of anti-gas-gangrene serum were given on the subsequent two days and 20 c.c. on each of the next two days. The patient developed a septic parotitis which required drainage, and his convalescence was protracted. The wound very gradually cleaned up and healed. The patient was discharged on Oct. 7.

PATHOLOGICAL REPORTS.—Muscle removed on July 20 :—

" One part of the surface was dark, and on section showed recent and some old hæmorrhage, with small proliferation of fibrous tissue and congestion of small vessels. The deeper section showed a slight tendency of intramuscular connective tissue to proliferate and rare foci of infiltration of small round cells at sites of vessels. Three nerves at the more superficial part showed marked interstitial neuritis, most fibres being replaced by fibrous tissue. At the piece of hæmorrhagic surface two or three Gram-positive rods were noted."

Muscle removed on July 23 :—

" Tissue consists entirely of muscle tissue in which numerous areas of necrosis are seen. In and around these areas of degeneration there is a heavy infection with bacilli that are most probably of the gas-gangrene group."

The following two cases are also considered worthy of inclusion in this report because of their clinical resemblance to the foregoing cases, suggesting a similar condition, although it was not definitely established.

Case 3.—W. H. S., admitted on April 13, 1928, received a gunshot wound of the right thigh in 1916, with injury to the great sciatic nerve. This had been sutured, a portion of the fascia lata removed from the outer side of the thigh being sutured round the nerve. An excellent recovery of the nerve had taken place, but the patient had always had aching pains in the thigh, with attacks of swelling, the thigh feeling at times ' as if it would burst '. In 1921 a small localized swelling had appeared on the outer side of the thigh, and this had gradually increased. He was admitted because of this and on account of his pains, which were increasing in frequency and severity.

ON EXAMINATION.—The patient had an extensive scar down the back of the thigh, adherent to the underlying muscle. A large muscle hernia was present on the outer side of the thigh where the fascial strip had been removed. Just above the muscle hernia a sensation as of gas crepitus was present. Clinically and radiographically there was no evidence of any bone disease, nor of arthritis of the hip- or sacro-iliac joints. He had no paresis or sensory defect ; reflexes were normal and the Wassermann reaction negative. X rays did not show the presence of gas bubbles in the tissues.

OPERATION (April 18, 1928).—Operation was performed to cure the muscle hernia. This was done by enfolding the muscle upon itself, the fascia being overlapped over this.

SUBSEQUENT HISTORY.—Three days after operation the patient complained of increased pain in the thigh. On examination of the wound small bubbles of gas were observed issuing from it. He was given 40 c.c. of anti-gas-gangrene serum. The wound oozed for a short time, but it was quite healed in three weeks. The patient was seen six months later. There was no recurrence of the hernia, but the pains and sensation of fullness of the thigh persisted. In view of this he was re-admitted and on Oct. 3 the sciatic nerve was explored. It was found bound down by fibrous tissue, which was removed and the nerve stretched. Prior to this operation the patient was given 10 c.c. of anti-gas-gangrene serum after desensitization. The wound healed without trouble. This operation relieved the pains in part, although he still had attacks at times, accompanied by a sensation of fullness of the thigh.

Case 4.—J. H. J., admitted on Feb. 4, 1929, had received a gunshot wound of both buttocks in 1917. The wounds discharged for a considerable time, finally healing in March, 1918. Since then he had always had aching pains in the buttocks, chiefly the left, which at times became swollen and felt ' tight '. In 1923 he had a more severe attack of pain and the buttock became swollen; the wound broke down, but practically no discharge occurred. The ulcer took five months to heal. Two months prior to admission a similar attack commenced, and the wound broke down two weeks later.

ON EXAMINATION.—An extensive transverse scar was present on each buttock, just above the gluteal fold. There was considerable loss of tissue of the left buttock, the scar in which was dense and depressed, and had in its

centre a deep ulcer from which there was practically no discharge. A probe could be passed forwards one inch. Slight tenderness was present just above and behind the left great trochanter, and the impression given here was as of palpating a sponge. Clinically and radiographically the spine, hip-, and sacro-iliac joints were normal. Rectal examination was negative and the Wassermann reaction negative. X rays showed an absence of any foreign body in this buttock ; a small superficial foreign body was present in the right buttock.

The patient was given 10 c.c. of anti-gas-gangrene serum. The swelling soon subsided and the ulcer gradually healed ; at no time did any discharge occur.

COMMENTS.

The outstanding features in the foregoing cases are the long history of vague cramp-like pains without definite localization ; the periodic swellings of peculiar type ; the repeated breaking-down of scars with prolonged ulceration without discharge ; the previous operations without gross untoward consequences ; and in *Cases* 1 and 2 the onset of acute gas gangrene almost ten years after the initial wound.

At no time in any of the cases did X rays show gas bubbles present in the tissues; this is of interest, because in several other cases where such bubbles have been shown, operation in the affected area was not followed by any untoward results.

The explanation suggested is that a nidus of organisms of low virulence existed in the muscles of the part. The activity of these organisms being mild, small portions only of a muscle would be irritated, and this unequal contraction might account for the cramp-like pains complained of, any gas produced being of such small quantity that it was readily absorbed. When the focus became stimulated, as by excessive use of the part, or external irritation, or by the laceration of tissues in its neighbourhood by operation, or, as in *Case* 2, by the bony or calcareous spicules, the activity would be greater, and the tension of the collecting gas might become sufficient to cause any weak scar to give way ; this ulceration would persist till the activity subsided. The onset of the acute gangrene in the first two cases would follow upon the production of an optimum medium for the organisms by the much greater destruction of muscle, especially if the actual nidus had been cut through, as, from the pathological reports, would appear to have happened in *Case* 2.

PERI-ARTERIAL SYMPATHECTOMY :

AN EXPERIMENTAL INVESTIGATION OF THE EFFECTS OF THIS OPERATION UPON LOCAL CIRCULATION.

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ALTHOUGH Leriche and his pupils have done much experimental work, at the present time peri-arterial sympathectomy may be described as an empirical operation, since its performance is based almost entirely on the favourable results observed clinically in certain cases to which it has been applied. In some parts of Europe the operation is enthusiastically performed for a great variety of conditions ; elsewhere surgeons look upon it with less enthusiasm, while most anatomists and physiologists regard with some astonishment the claims of its most ardent advocates. It therefore appears desirable to attempt to obtain some experimental evidence for or against the procedure. Is the operation merely a surgical fashion of the moment, or has it any underlying scientific basis to justify its performance for conditions in which it is desirable to increase the vascularity of the periphery of the limb ? In order to decide this question it is in the first place advisable to consider the usual method of performing the operation on man, because it is obviously necessary to simulate as closely as possible the conditions obtaining in human surgery before drawing deductions from any experimental work on animals.

The Operation on Man.—As performed in man, peri-arterial sympathectomy is most often applied to the femoral artery, from which a cuff of adventitia is destroyed, either by peeling it off the vessel,[1, 2] infiltrating it with alcohol,[3] or painting it with phenol.[4] The operation is also performed on the popliteal, the subclavian, and the brachial arteries, and by certain surgeons on the carotids, the abdominal aorta, and the iliac vessels. In but few instances has it been carried out upon more peripheral vessels.

The chief problem presented to us was to see whether we could obtain any experimental evidence of increased peripheral vascularity following performance of the operation upon the femoral, the femoral together with the popliteal, and the carotid arteries of animals.

Animals Used.—For the investigation we decided to use cats and albino rabbits. The vasomotor reactions of the cat are easily elicited, and from the experimental standpoint are already known in some detail. Furthermore, the size and structure of their arteries make the operation of peri-arterial sympathectomy technically possible. Albino rabbits were used because changes can be easily observed in the conspicuous vessels of their large pale ears.

Nature of Experiments.—Four types of experiment have been attempted:—

1. Following peri-arterial sympathectomy of one femoral artery of the cat, inert dye substances were injected into the peripheral vascular system, and, subsequently, in order to determine the distribution of the dye in the vessels, a post-mortem histological examination of corresponding parts of both hind limbs was carried out. After performing a few of these injection experiments it was decided to abandon them for others better designed to afford information of the vascular system of the limb.

2. Following the work of Hunt,[5] Dale and Richards,[6] and Burn and Dale,[7] certain substances, such as acetyl choline, histamine, and adrenalin, known to act on the arterial and capillary systems, were used to differentiate the responses of normal limbs and those upon which peri-arterial sympathectomy had been performed.

3. The rate of blood-flow through normal limbs and through those upon which the operation had been performed was compared in a further series of experiments by estimating the heat production in each limb by a calorimetric method.

4. The state of the circulation in the ear of the albino rabbit being readily apparent, experiments were carried out to ascertain the effect of the operation when performed upon the arteries supplying the ear.

The Actions of Acetyl Choline, Histamine, and Adrenalin upon the Blood-vessels of a Limb following Peri-arterial Sympathectomy.—Heretofore no attempt appears to have been made to ascertain the response to the above substances of a limb upon which peri-arterial sympathectomy has been performed. Hunt has shown that acetyl choline is a powerful dilator of arterioles and capillaries, while Dale and his collaborators have shown that in the cat histamine is a dilator of capillaries and a constrictor of arteries. Acting on the assumption that a vessel already dilated is incapable of giving a dilator response as great as that capable of being elicited from a more constricted vessel, we have used these substances to assess the condition of the circulation.

Changes in the calibre of vessels in the limb have been measured as changes in volume by the plethysmograph, the technique adopted being substantially that described by Dale and Richards. The plethysmographs consisted of glass cylinders, 14 in. long and $2\frac{1}{4}$ in. diameter, open at one end, the other end furnished with two small openings, one of which was used for filling the cylinder with water, the other for connecting it to a small float recorder working on a kymograph (*Fig.* 284). An invaginated rubber cuff made a water-tight joint with the limb. We found it necessary to use very thin rubber for this purpose, since while we required a joint that would not leak we had also to avoid undue pressure on the limb with consequent interference with a free circulation. The animal's fur was thoroughly greased with vaseline to add to the efficiency of the joint. The float recorders were of a small cylindrical pattern and of equal dimensions and leverage. In order to check any mechanical errors due to the recorders the tubes connecting them to the plethysmographs were changed over during the course of certain of the experiments. A hollow needle was tied into a fore-limb vein for the introduction of solutions. Blood-pressure was recorded through a cannula tied into the common carotid artery and connected with a mercury manometer

recording on the kymograph. Anæsthesia was maintained by ether vapour delivered through a cannula fixed in the trachea through an opening in its upper rings.

The femoral artery in the cat is easily exposed on the inner (ventral) surface of the thigh in an intermuscular furrow which can be felt extending from the inguinal (Poupart's) ligament along the line of the axis of this part of the thigh. On opening the deep fascia the femoral artery, accompanied by a nerve and a large vein which is usually superficial and overlies the artery, is found embedded in fatty areolar tissue.
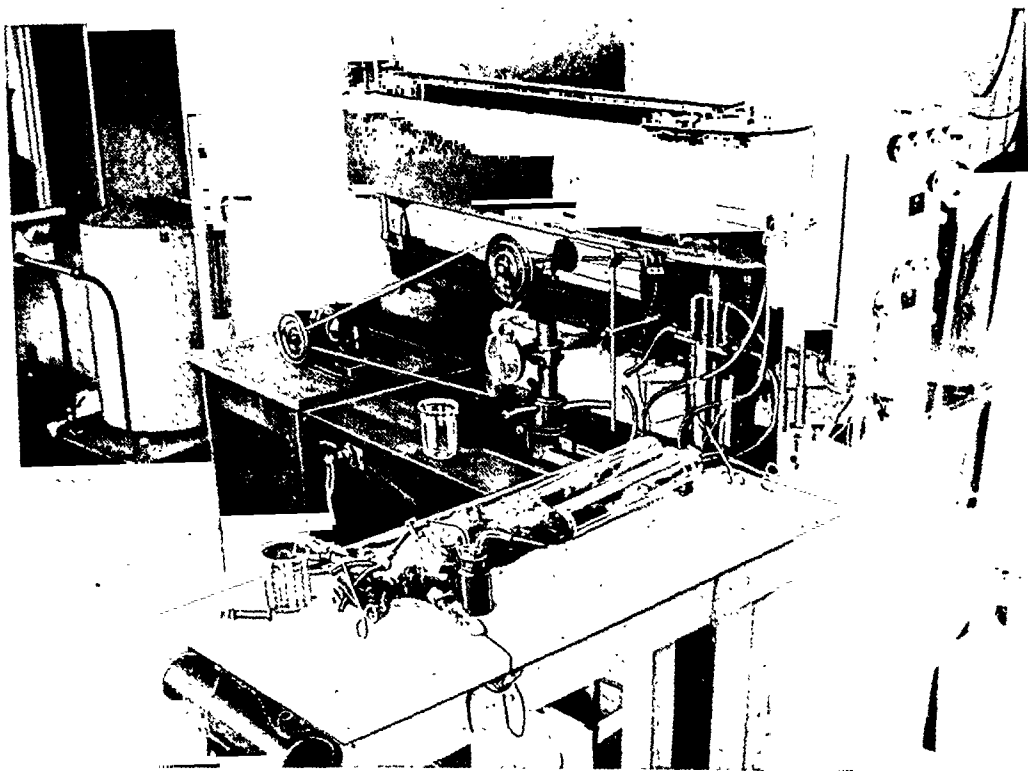
Fig. 284.—Photograph of an actual experiment in course of performance. The apparatus used and the method of obtaining the tracings shown in *Figs. 285-289* are shown.

The Operation on the Cat.—The artery was dissected free, lifted out of its bed, and either carefully stripped of its adventitia for about a centimetre of its length or phenolized by painting it with a fine camel-hair brush dipped in concentrated phenol solution, care being taken not to contaminate the adjacent nerve and vein. In order to avoid this contamination a narrow strip of thin sheet rubber was first placed beneath the artery, and, after well painting the vessel and rolling it first to one side and then to the other so as completely to phenolize its circumference over a length of approximately one centimetre, the vessel was dried carefully with cotton-wool pledgets and replaced in its bed. In some animals the fascia was closed with interrupted catgut sutures, in others there was no separate closure of the fascia. The

skin was sutured with either silkworm gut or catgut, silkworm gut being used in the majority of experiments. In certain experiments one or both femoral arteries were exposed, isolated, and phenolized after the limbs had been placed in the plethysmographs and some preliminary tracings obtained. In these experiments the wounds were protected by saline pads, which were kept moist.

The Effects of Peri-arterial Sympathectomy on the Artery.—In human subjects we have noticed, in confirmation of frequently repeated observations of others, that when the artery is healthy, as in young patients, a localized contraction, slightly greater in extent than the length of vessel stripped, takes place at the site of stripping. If, however, the vessel is sclerosed, no change takes place. In the cat we observed a constriction after phenolization in some animals, in others no change was seen, while in still others, in contra-distinction to the constriction seen in the human artery, a dilatation was noticed. When this dilatation occurred it did not appear to be due to a mechanical weakening of the vessel wall, as we first suspected, because we observed it following phenolization as well as after mechanically stripping the vessel. In no case of stripping were we able to produce the local contraction seen in the human subject, but it was clearly demonstrated after phenolization.

The Popliteal Artery.—We considered that the sympathetic fibres to the vessels might leave the main nerves to the limb at intervals, as these nerves approached the periphery. Woollard[8] has shown that this arrangement exists in the cat, while Blair and Bingham[9] have more recently demonstrated the condition in man.

Because of this arrangement of nerves we extended certain of our experiments, combining stripping or destruction of the network on the femoral artery with similar treatment of the popliteal.

The popliteal artery in the cat is deeply placed in the animal's ham and obscured by the large vein which accompanies it and overlies its dorsal aspect. With a little care we found it possible to expose and isolate the artery through a longitudinal incision in the popliteal space, and, after guarding against contamination of the surroundings of the vessel in the same way as in the case of the femoral artery, to phenolize the vessel over a length of nearly five or six millimetres. The sciatic and external popliteal nerves were well away from the site of phenolization and easily avoided when painting the artery.

The Effects of Peri-arterial Sympathectomy on Local Circulation.—Immediately following the operation there is no obvious change regularly observable in the general circulation of the limb. We have taken note of the colour of the pads of the paws when these were not pigmented, and have noticed that, although normally of a pale colour, in a few cases following the operation a slight flushing or reddening of the pads occurred, indicating a dilatation of the surface capillaries. The paws of the majority of the animals were too pigmented, however, to permit the use of this method of estimating any change in the circulation, and we have therefore made use of the reactions of acetyl choline, histamine, and adrenalin to measure the degree of vascular dilatation following the operation.

Acetyl choline dilates both arteries and capillaries, and following its introduction into the blood-stream there is a fall in blood-pressure owing to

the diminution of the normal vascular resistance. The dilatation of vessels is measured in the plethysmograph as an increase in limb volume. Blood-pressure is rapidly restored to its normal level, apparently in the first place by the action of the vasomotor centre through the vasoconstrictor nerves increasing the tone of the vessels, and secondly by the excretion of the acetyl choline.

The effect of histamine in the cat is more complex, since there is a double and somewhat paradoxical action, the arteries being constricted but the capillaries dilated. The chief dilatation occurs in the vessels of the skin,
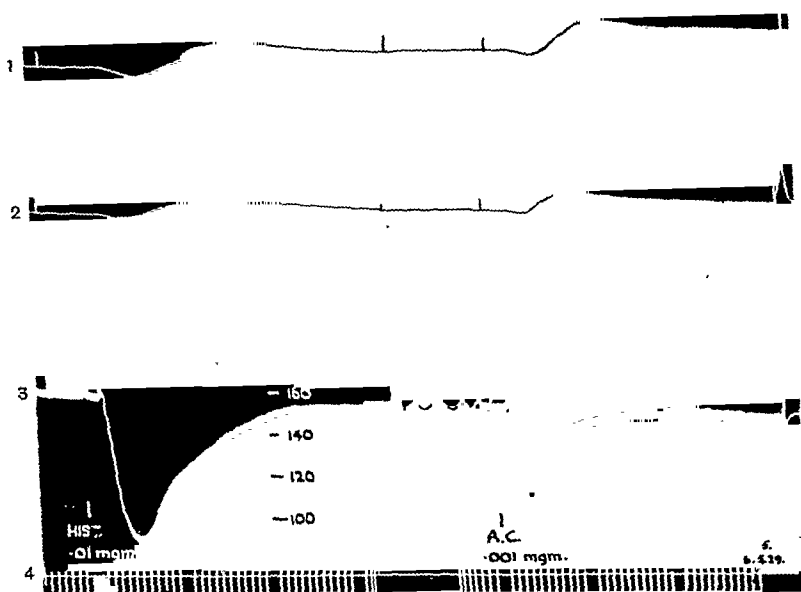
Fig. 285.—Tracings showing limb volume responses and that of the carotid mean blood-pressure to intravenous injection of histamine and acetyl choline. The left femoral artery had been phenolized approximately ten minutes before the record was taken. Reading from above downwards the tracings represent: 1, Right limb volume; 2, Left limb volume; 3, Carotid mean blood-pressure; 4, Time in 5-second intervals.

Owing to vascular dilatation in the limb operated upon there is less response to histamine and acetyl choline in this limb than in the normal limb.

and to demonstrate this opening of vessels as an increase in limb volume, care must be taken to anæsthetize the animal so as to avoid struggling while keeping the anæsthetic fairly light. As little disturbance as possible should be caused to sensory nerve-endings by the various operative procedures. Assuming that these precautions are taken, intravenous injection of histamine is followed by a fall in blood-pressure and an increase in limb volume—the latter evidence of capillary dilatation.

If peri-arterial sympathectomy causes an increased supply of blood to a limb or other portion of the body it can only do so by dilating the vessels.

supplying the part. In consequence, the vessels involved will be unable to give their usual responses to acetyl choline and to histamine, since they are already partially dilated. An experiment in which this possibility was investigated is depicted in *Fig.* 285. The tracing shows records of the volume of the [two hind limbs. The upper tracing is from the right limb, the lower from the left, and shows the volume changes occurring approximately ten minutes after femoral phenolization. Below these two is the record of arterial blood-pressure, and at the foot of the tracing a time record with intervals of five seconds. Following the injection of 0·01 mgrm. of histamine contained in 1 c.c. of saline, there is a transient fall in mean blood-pressure from 155 mm. Hg to 90 mm. Hg. An increase in limb volume occurs a little later than the onset of the blood-pressure fall, owing to the time period required for the transportation of histamine to the vessels of the hind limbs. It is seen that both limbs dilate, but that a greater response is elicited from the normal limb, indicating that the vessels of the other limb are already partially opened up. A similar differentiation in the response of the two limbs to acetyl choline is shown in the second half of the tracing. Such experiments would indicate that dilatation follows peri-arterial sympathectomy, and further support of this is given by the following experiment :—

FIG. 286.—Tracings showing limb volume responses and that of the carotid mean blood-pressure to acetyl choline and adrenalin. The right femoral artery had been phenolized approximately five minutes before the record was taken. Reading from above downwards the tracings represent : 1, Left limb volume ; 2, Right limb volume ; 3, Carotid mean blood-pressure ; 4, Time in 5-second intervals.

Owing to vascular dilatation in the limb operated upon there is a smaller response to acetyl choline and a greater to adrenalin than in the normal limb.

Adrenalin in fairly large doses constricts both arteries and capillaries, causing a rise in blood-pressure, quickly compensated by the action of cardiovascular reflexes. Diminution in limb volume gives evidence of the vascular constriction. In the experiment depicted in *Fig.* 286 the altered response to acetyl choline, which we have already described, was first demonstrated, and following that an injection of 0·1 mgrm. of adrenalin was made. The lower of the limb-volume tracings, that from the limb operated upon, shows a greater diminution in volume. This augmented constrictor effect of adrenalin was to be expected if the limb vessels had undergone dilatation

following the destruction of the peri-arterial network, and it therefore confirms the supposition that dilatation had taken place.

Such experiments as these appear to indicate that peri-arterial sympathectomy is undoubtedly followed by an increased blood-supply to the part. Further experiments, however, have convinced us that such dilatation as occurs is but evanescent. In many experiments we have had difficulty in demonstrating the changed response to histamine or acetyl choline, and in others in which differing responses were present at the commencement, these had disappeared before the termination of the experiment. On two

A   B   C
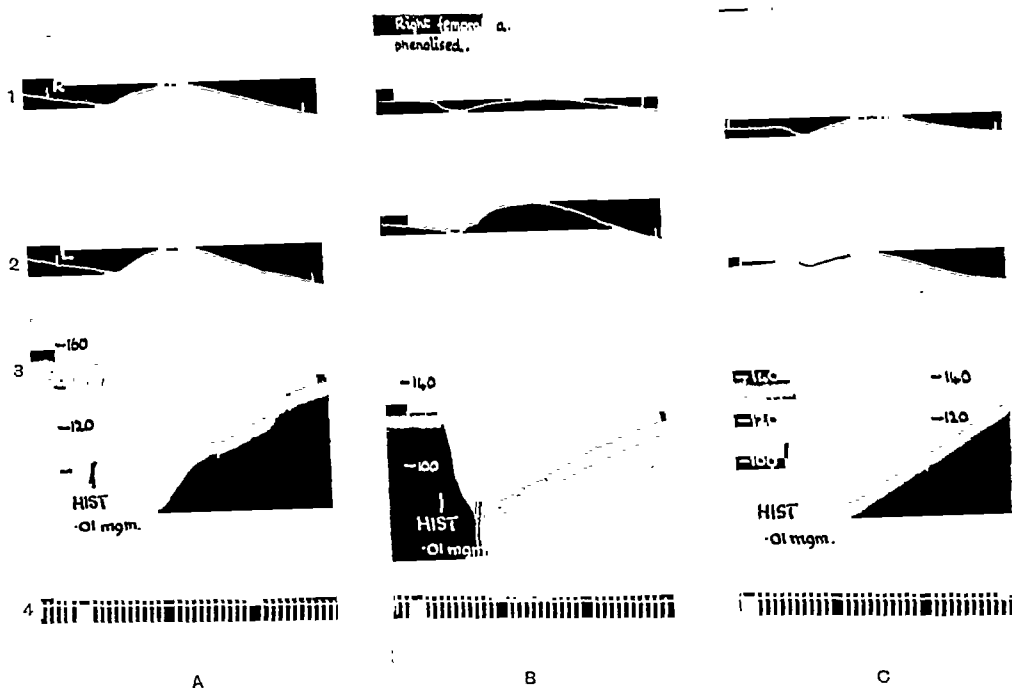
FIG. 287.—Tracings showing limb volume and mean carotid blood-pressure responses to histamine following femoral peri-arterial sympathectomy. In all these records reading from above downwards the tracings represent : 1, Right limb volume ; 2, Left limb volume ; 3, Carotid mean blood-pressure ; 4, Time in 5-second intervals.

A shows the response to histamine when both limbs are normal, B the response *immediately* following phenolization of the right femoral artery (upper tracing), and C the response three minutes after the phenolization. It will be seen that although the histamine dilatation has disappeared in the right limb following immediately upon the phenolization, three minutes later the curves are again parallel as they were at the beginning of the experiment.

occasions, moreover, we have been able to obtain quite definite evidence, showing that the limb-volume changes rapidly disappear. The tracings, A, B, and C in *Fig.* 287 are taken from one of these experiments. Both limbs were placed in plethysmographs and both femoral arteries were exposed and prepared for phenolizing. The reactions to histamine and acetyl choline were then tested and both were found to give a fall in blood-pressure with good limb dilatation. After a brief rest. the right artery was phenolized and the effect of histamine and acetyl choline again measured. The dilatation

previously present in the right limb had disappeared, and there was only a slight preliminary constriction, due in part to a passive following of the reduction in blood-pressure and also to the constricting action of histamine on the arteries. The response to acetyl choline remained practically unchanged. Three minutes were allowed to elapse, and histamine and acetyl choline were again injected. The dilator response to histamine had re-appeared, indicating the regaining of capillary tone.

A similar experiment was then performed upon the left limb. Immediately following the phenolizing of the artery there was a loss
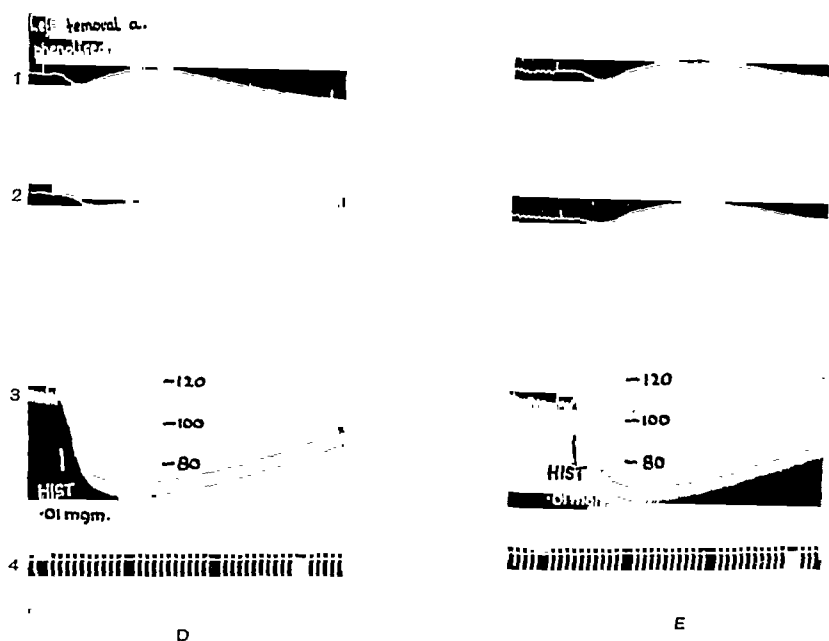
FIG. 288.—The same experiment as in *Fig.* 287. The left artery has now been phenolized. The tracings read from above downwards as in *Fig.* 287. It will be seen in D that the histamine dilatation has disappeared *immediately* following phenolization, but that in E, three minutes later, the curves are again parallel as in A and C (*Fig.* 287).

of capillary tone, shown by the disappearance of the histamine limb dilatation. Within three minutes this was restored (*Fig.* 288, D and E). Finally, as a control, to demonstrate that the actual painting of the arterial wall was not the factor concerned, the right artery was repainted, histamine was again injected, and it was now found that the histamine dilatation had not disappeared.

In the experiments thus far described peri-arterial sympathectomy was confined to the femoral artery. *Fig.* 289 gives an indication of the vascular responses of the hind limb in an experiment where both femoral and popliteal arteries were phenolized. The upper tracing is the left limb which was operated upon. The responses from the two limbs are nearly identical, indicating that any vascular dilatation immediately following the destruction

of the peri-arterial network has disappeared during the thirty minutes which have elapsed since the performance of the operation.

We were therefore led to the conclusion that while in some cases peri-arterial sympathectomy leads to an increased blood-supply, such an increase is only transient.
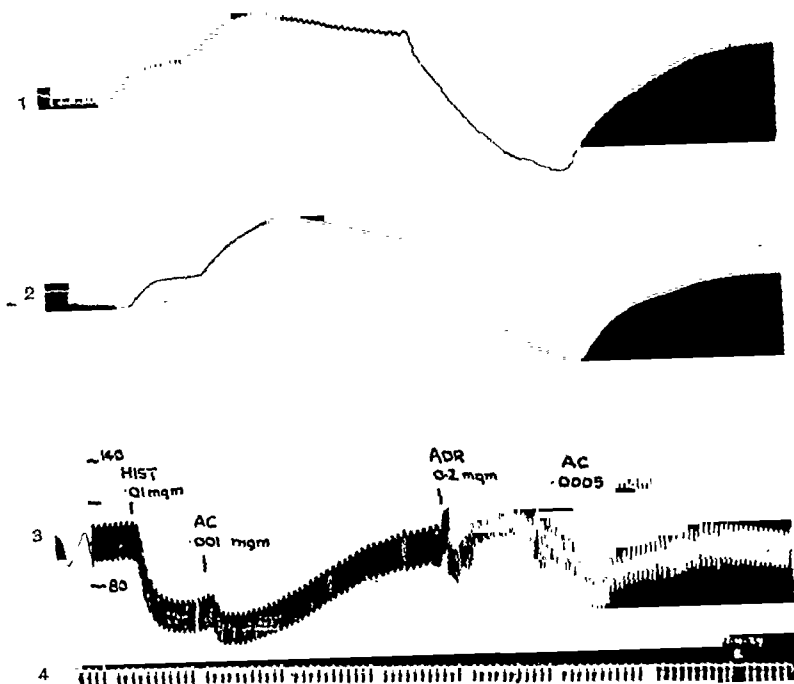
Fig. 289.—*Tracings showing limb volume and mean carotid blood-pressure responses to histamine, adrenalin, and acetyl choline. One limb is intact, the other has been subjected to femoral and popliteal sympathectomy performed by phenolizing these arteries. Reading from above downwards the tracings represent :* 1, Left limb volume (sympathectomized arteries) ; 2, Right limb volume ; 3, Carotid mean blood-pressure ; 4, Time in 5-second intervals.

It will be seen that although the main artery of the right limb has been phenolized in two stages of its course, at the time of the experiment, about thirty minutes following the operation, the responses of the two limbs to vascular constrictor and dilator substances are practically identical.

Calorimetric Studies following Peri-arterial Sympathectomy.—Stewart[10] has demonstrated that the rate of blood-flow through a limb may be assessed by measuring its heating capacity by calorimetric methods. Recently Brown and Rowntree[11] in man have measured the heat production of arms and legs following peri-arterial sympathectomy of the brachial and femoral arteries respectively. They report that a fortnight after stripping the artery it was impossible to demonstrate any vasodilatation in the limb.

For measuring heat production we employed two glass cylinders each 14 in. long. These were clamped vertically, and each was closed at the bottom

by a stopper carrying a mechanical stirrer (*Fig.* 290). A thermometer reading to 0·05° C. was introduced into each cylinder through a narrow side tube, junction being made by a small rubber cuff. The anæsthetized animal was held in a sling above the calorimeters so that the hind limbs hung vertically within them. Equal volumes of water, usually 100 c.c. cooled down to 8° C., were poured simultaneously into the cylinders, and increases of temperature recorded at two-minute intervals for twenty minutes. A series of control readings were taken to determine the rate of water heating without the limb.
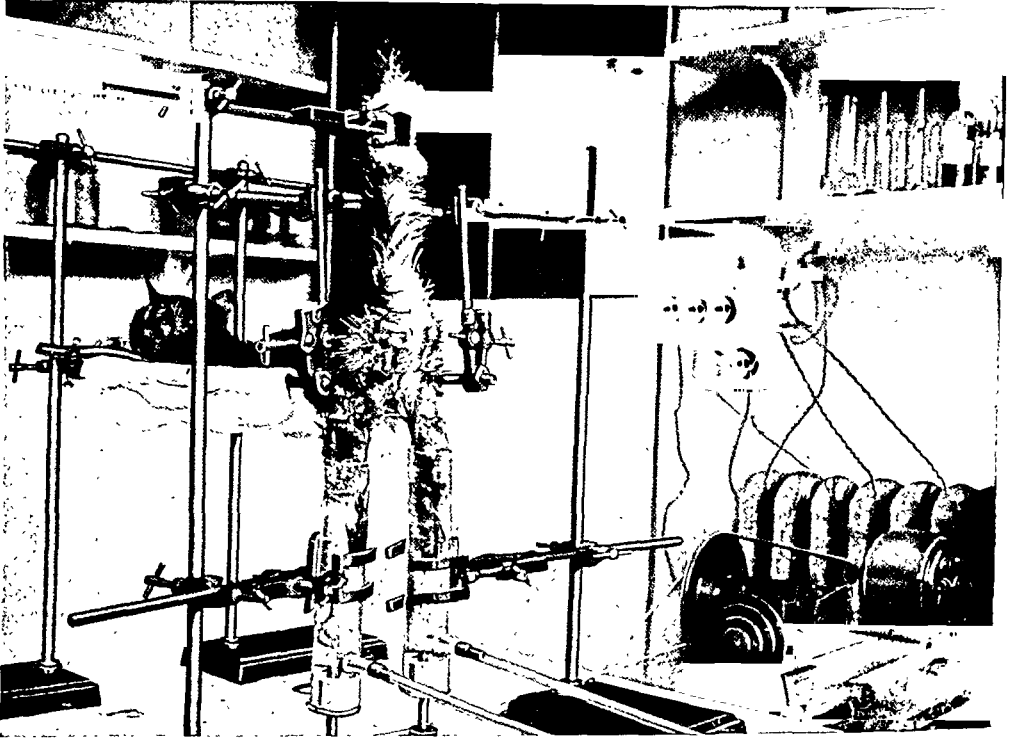
FIG. 290.—Photograph of apparatus used for estimating temperature changes in the limbs following peri-arterial sympathectomy.

Eight cats were examined, and the heat production in the hind limbs was measured at periods varying from a few minutes up to twelve days following the operation. *Figs.* 291 and 292 are tracings from two of these experiments. In no case have we observed any evidence of vasodilatation, the heating capacity of the limb operated upon and of the normal one being identical. In those experiments where the femoral artery was phenolized and the animal permitted to recover, three or four calorimetric records were taken within a fortnight, and afterwards the reactions of the vessels to histamine and acetyl choline were determined as described in the previous section. In four cats which were examined in this manner, the volume responses of the two limbs were identical.

The Effect of Peri-arterial Sympathectomy of the Common Carotid Artery on the Circulation in the Ear of the Rabbit.—The original aim of this series of experiments was to isolate the individual arteries supplying the ear
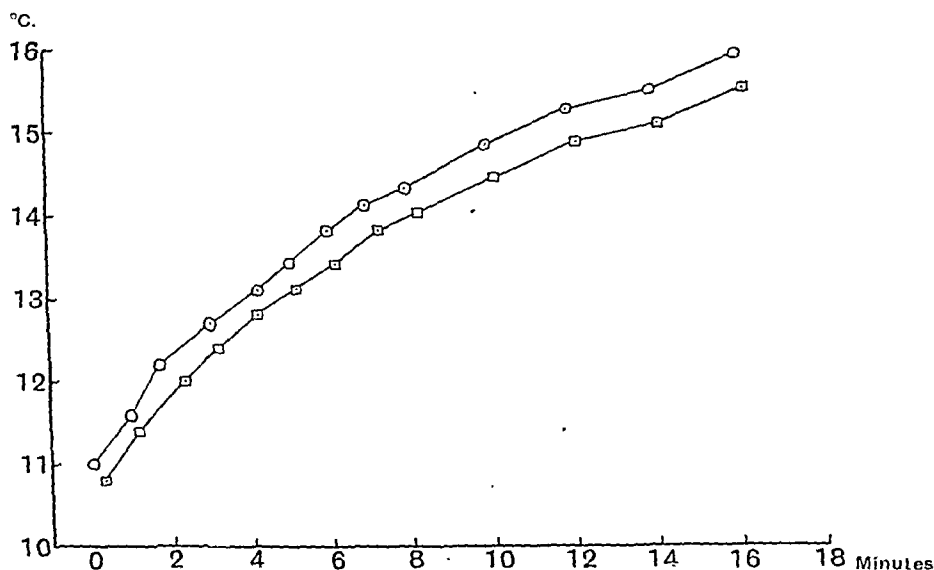
Fig. 291.—Temperature tracings of the hind limbs of a cat subjected to peri-arterial sympathectomy of the right femoral artery six days previously. The lower tracing is from the right limb. Description in text.
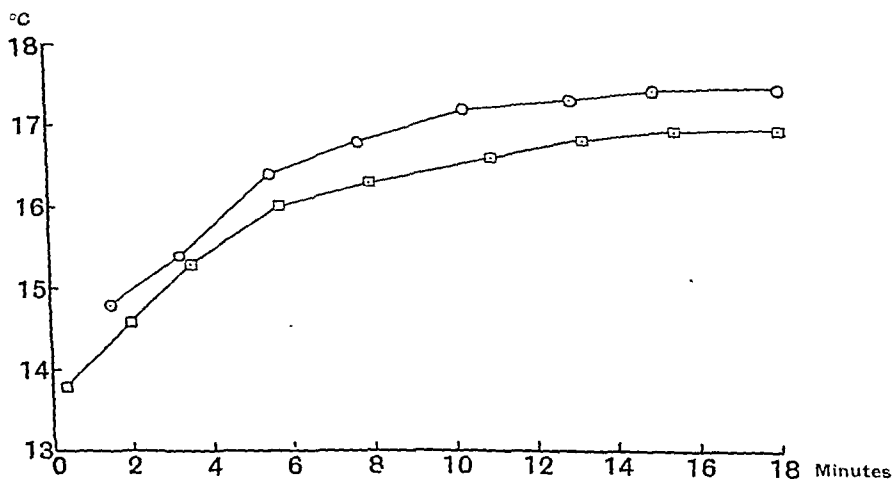
Fig. 292.—Temperature tracings of the hind limbs of a cat subjected to peri-arterial sympathectomy by phenolization of the left femoral artery ten minutes previously. The lower tracing is from the right limb. Description in text. (The left thermometer reads 0·5° C. above the right in all records.)

of the albino rabbit and to destroy the peri-arterial network, but because these arteries are small and technically rather difficult to isolate, we directed our attention, after two abortive experiments on the terminal branches, to

the destruction of the nervous elements situated on the common carotid artery.

The artery was exposed through a mid-line incision extending downwards for about 4 cm. from the level of the thyroid cartilage, the sternomastoid muscle being retracted outwards. The carotid artery was separated from its surrounding structures and isolated upon a thin strip of sheet rubber as pre-

FIG. 293.—Head and ears of albino rabbit six hours after phenolization of tne right carotid artery under ether anæsthesia. The vasodilatation in the right ear is apparent.

viously described for the femoral artery. Taking great care to avoid con-tamination of its surroundings, the artery was painted with phenol, and after drying returned to its original position. The wound was closed with interrupted silkworm-gut sutures.

No immediate change in the vessels of the ear was noticed in four rabbits treated as above, but six hours after the operation in three of these

rabbits the ear of the side which had been operated upon showed well-marked reddening and was warmer to touch than the other ear (*Fig. 293*). This increased vascularity persisted throughout the next day, but in most of the animals had subsided and disappeared by the end of the second. Three weeks after the first operation the other carotid artery was exposed in each case, and following its phenolization a transient vasodilatation was observed in the ear of the same side, similar to that produced in the opposite ear following the first operation.

One rabbit proved an exception. The left carotid artery was exposed and phenolized, but search was also made for the sympathetic trunk. This was found and stimulated electrically, a constriction of the ear vessels during the period of stimulation being obtained. It would appear that some damage was done to the sympathetic trunk, since ten minutes after the observation the left ear vessels were dilated, and continued so for twenty-four days. At the end of this period the right carotid artery was exposed and phenolized, with a result similar to that obtained in the other three animals, the consequent vasodilatation of the ear being only transient. This and other experiments in which the sympathetic trunk was divided have shown how much better and more lasting is the vasodilatation following division of the main sympathetic cord than that produced by denervation of the carotid artery.

It should be mentioned that vascular reactions in the ears of the rabbit appear to be very easily elicited; thus stimulation with the faradic current of the cervical sympathetic, the carotid artery, or even the skin at the base of the ear, causes the vessels to constrict and the ear to become pallid.

Conclusion.—Although we have noticed individual variations in the reactions of both sets of animals employed for these experiments, the majority gave the results which are here described, and we therefore conclude that peri-arterial sympathectomy does increase the local circulation, but that its effects are exceedingly transient.

SUMMARY.

1. An experimental investigation has been carried out of the effects of peri-arterial sympathectomy in animals.

2. A description of the methods employed for the destruction of the peri-arterial nerve network is given.

3. The effect of peri-arterial sympathectomy performed upon the femoral or femoral and popliteal arteries of the cat has been measured by comparison of the responses to certain substances of the vessels of the limb operated upon with those of the corresponding normal limb.

4. Vasodilatation follows the operation, but is very transient.

5. Comparison of the heat production in the limbs of the cat following the performance of the operation on one side, indicates that no permanent vasodilatation results.

6. Peri-arterial sympathectomy performed upon the carotid artery of the albino rabbit results in a vasodilatation of the corresponding ear lasting for about forty-eight hours and then disappearing.

7. Division of the main sympathetic trunk produces a greater and more lasting vasodilatation than peri-arterial sympathectomy of the corresponding main artery.

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THE EFFECT OF ABDOMINAL OPERATIONS ON THE MECHANISM OF RESPIRATION:

WITH SPECIAL REFERENCE TO PULMONARY EMBOLISM AND MASSIVE COLLAPSE OF THE LUNGS.

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It seems well established that operations on the abdomen are definitely more liable than surgical procedures in other parts of the body to be followed by two types of complication : (1) Pulmonary embolism and thrombosis ; and (2) Collapse and inflammatory affections of the lung bases.

Pulmonary Embolism and Thrombosis.—With regard to these conditions, a considerable amount of evidence exists to show the etiological importance of abdominal operations. For example, Petren[1] (1913) analysed 439 cases of pulmonary embolism from the literature, 83 per cent of which followed abdominal operations ; while of his own series of 45 fatal post-operative cases, no fewer than 40 were the sequel of abdominal procedures. Lister[2] (1927), in a very carefully controlled study based on the records of the London Hospital for the years 1909 to 1925 inclusive, was able to bring forward definite statistical proof of the predisposing influence of an abdominal operation. Ducuing[3] (1929) showed that in a large collection of clinical examples of thrombosis the percentage incidence after abdominal operations was much greater than that following operations elsewhere. The present writer was able to obtain figures from 31 of the big London hospitals for the year 1926. Out of a total of 54,253 operations, there were 50 cases of fatal pulmonary embolism, of which no fewer than 43 followed abdominal operations. Again, out of 23 cases of post-operative pulmonary embolism met with in the five years 1923–1926 in the Post-mortem Room of the Middlesex Hospital 20 were abdominal operations. Taking as a sample the total number of operations performed in one year (1926) in the above hospital, it was found that extra-abdominal operations (excluding dental, aural, and ophthalmic) were more frequent than abdominal in the proportion of, approximately, 2 to 1 ; so that in this series the predisposing influence of the abdominal incision is again well brought out. In the early part of the present century it was thought that lower abdominal and pelvic operations were especially liable, presumably because operations in these regions were the most frequently performed. But with the spread of surgical enterprise to all parts of the abdominal cavity, it gradually became realized that it was not so much an operation in any special part of the abdomen, but abdominal operations generally, which showed this particular predisposition to thrombosis and embolism. Thus, Lister[2] was able to detect no undue frequency following pelvic operations, while the percentage

in *Table III*, while *Table IV* gives similar readings from a group of control non-abdominal cases. It will be seen that the results are so variable, probably owing to uncontrollable extraneous factors, that it is difficult to come to any definite conclusions. Some cases show a bigger volume of tidal air with an abdominal wound, others a smaller. But if a comparison is made with the control series, one may note that a reduction in the amount of air expired

Table IV.—CONTROLS : NON-ABDOMINAL CASES.

| NO. OF CASE | SEX AND AGE | OPERATION | TIDAL AIR | | + OR − |
			Before Operation	After Operation	
1	F., 48	Radium to cervix	335 c.c.	416 c.c.	+
2	F., 40	Examination under anæsthetic	271 c.c.	290 c.c.	+
3	M., 41	Radium into perineum ..	310 c.c.	353 c.c.	+
4	F., 48	Perineorrhaphy	372 c.c.	311 c.c.	—
5	M., 58	Excision of carcinoma of anus	232 c.c.	307 c.c.	+
6	F., 48	Radical carcinoma of breast ..	260 c.c.	428 c.c.	+
7	M., 62	Amputation of breast	406 c.c.	534 c.c.	+

with each normal respiration is more commonly met with following abdominal than other types of operation. It seems a fair conclusion, therefore, that, while an abdominal operation has no very constant effect on the depth of a normal respiration, it shows a somewhat greater tendency than operations elsewhere to be associated with a reduction.

The Movements of the Diaphragm.—To determine the precise manner in which an abdominal operation interferes with respiration it will now be necessary to go into the question in more detail ; and one may conveniently begin with the chief muscle of inspiration, the diaphragm. The movements of this muscle were studied by means of radiographs taken before and after operation. Since it was found impracticable within a few days of operation to transport patients to the skiagraphical department for screen examinations, the following standard technique was adopted. Before operation two X-ray photographs of the chest and diaphragm were taken with a portable apparatus at the patient's bedside, one at the end of expiration, and the other with the breath held in deep inspiration. Two days after operation similar exposures were made, the patient's bandages being temporarily loosened. On both occasions care was taken to have the position of the patient relative to the X-ray tube the same. All photographs were taken by the same radiographer, using the same apparatus. The technique being thus standardized, the results may be considered comparable. In all, seven cases submitted to abdominal operations were studied, while four cases of radical excision of the breast were used as controls. The breast operation was chosen as a control because, in spite of its proximity to the respiratory apparatus. it is recognized as being rarely followed by thrombotic or embolic complications.

Results of Investigation of Abdominal Cases.—In all seven abdominal cases the respiratory excursions of the diaphragm were diminished. In one case (an upper abdominal laparotomy) the diminution of diaphragmatic movement was classified as 'slight'. In three cases (a hysterectomy.

cholecystectomy, and a radical cure of an inguinal hernia) the diminution was classified as 'moderate'. In three cases (a cholecystectomy, a laparotomy, and a pylorectomy) it was classified as 'marked'.
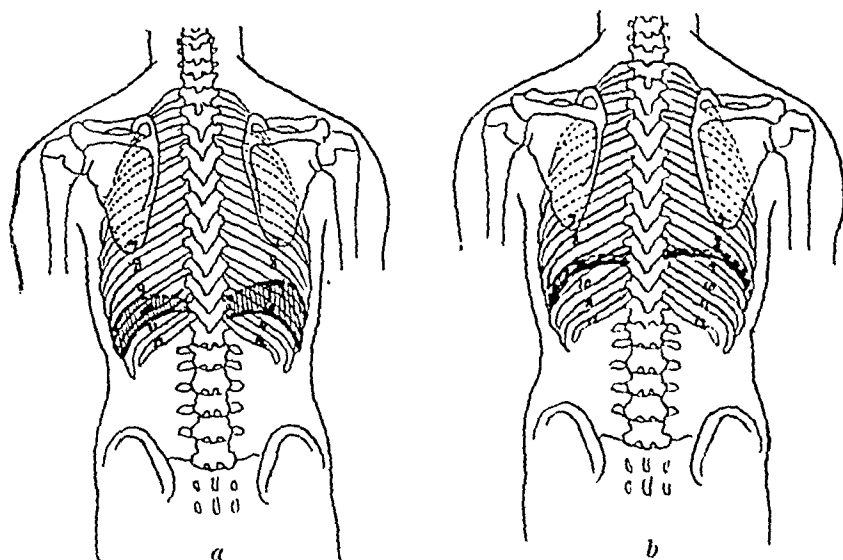
FIG. 294.—'Marked' diminution of diaphragmatic movements after cholecystectomy (as shown in red). *a*, Before operation; *b*, After operation.
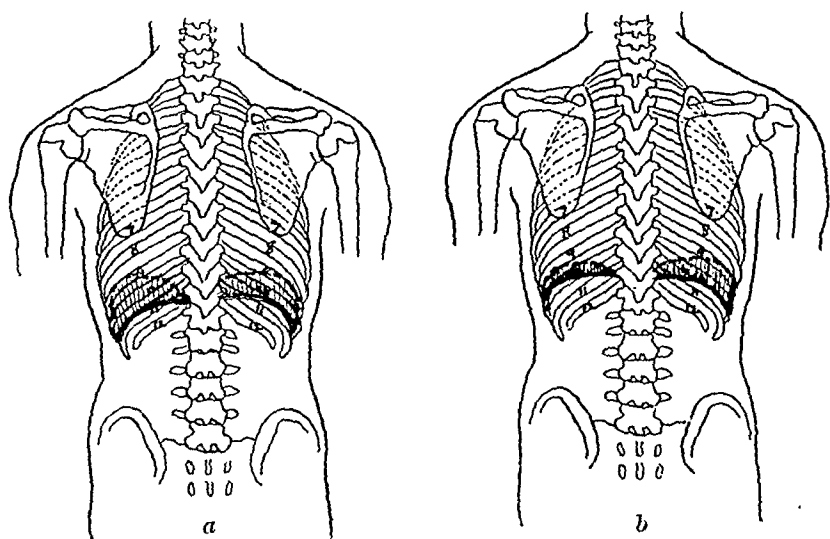
FIG. 295.—'Moderate' diminution of diaphragmatic movements after cholecystectomy. *a*, Before operation; *b*, After operation.

Figs. 294 and 295 illustrate typical cases, the former being an example of 'marked', and the latter of 'moderate' diminution. In two cases the diaphragmatic movements, in addition to being diminished, took place about a higher level, owing to pressure from below by distended coils of gut.

Results of Investigation of Control Cases.—Of the four cases of radical operation for carcinoma of the breast, three showed as wide a range of diaphragmatic movement after operation as before, while one case showed a diminution which was less than that classified as ' slight ' in the abdominal cases, and may therefore be termed ' very slight '. In one case the diaphragmatic movements on the operated side were not only as extensive as before operation, but took place at a lower level. This patient complained of pain on the affected side of the chest on deep inspiration, and it is possible that as a result of this there was a diminution of costal respiration, and a compensatory increased descent of the diaphragm on that side.

Suggested Means of Combating the Diaphragmatic Inhibition.—Many efforts have been made by surgeons to overcome this inhibition of the diaphragm after an abdominal operation, but so far without any uniformity of success. Post-operative deep-breathing exercises, which are often recommended and employed, labour under the disadvantage that, while they will certainly induce a sluggish muscle to move efficiently, they have little effect on a diaphragm which is being seriously inhibited by pain impulses from an abdominal wound. Indeed, one sometimes finds that a patient who clinically appears to be performing the exercises most efficiently, is really, when X-ray examinations are made, using the diaphragm very little. The suggested use of inhalations of CO_2 gas as a routine after operation for the same purpose seems open to similar objections. The problem has sometimes been attacked from the other side, and attempts made to diminish the pain in the abdominal wound, which is the cause of the trouble. Novocain and other such local anæsthetics, however, are too transitory in their effects to have any real value in this connection ; while, as to the suggestion that morphia might be useful, the writer found that in the only case in which he studied its action, so far from enabling the diaphragm to descend more efficiently, its use caused this muscle to become more elevated—thus suggesting, if this one case be a criterion, that any beneficial effect that morphia may have on the pain is more than counterbalanced by the general loss of tone resulting from its use. We must therefore conclude that at present the problem of efficient diaphragmatic movement in the presence of an abdominal wound remains unsolved.

Expiration.—While the effect of an abdominal operation on the diaphragm has been the subject of much inquiry and speculation, the corresponding effect on the expiratory muscles has excited comparatively little interest. Presumably this is because their particular study presents greater difficulties. We have already noted that patients with abdominal incisions often complain of pain in the wound at the end of a long expiration owing to the contraction of the abdominal muscles involved in this act, but it is not possible to determine directly the degree of such interference. In this study the effect of an abdominal incision on the muscles of expiration was investigated indirectly by a determination of the alveolar CO_2, the rationale being the following.

If a patient expires deeply, and the last portion of expired air is trapped and analysed, an estimation of the percentage of CO_2 in the alveolar air may be made. If for any reason the patient is unable to expire so deeply, the

sample becomes diluted by the air in the trachea and bronchi, a lower CO_2 reading being obtained. Provided, therefore, that one has a pre-operative standard for a given individual, and that care is taken to exclude patients with acidosis and other gross metabolic disturbances, the degree of dilution of the sample of air taken at the end of expiration may be looked upon as a rough index of the amount of interference with the muscles of expiration.

A series of patients before and after an abdominal operation were investigated in conjunction with Mr. H. F. MacLaglan, who analysed the samples in a Haldane's gas apparatus. The specimens were collected by the syringe technique described by Dodds.[7] The following readings were obtained from a typical case—B. C., male, age 30. Operation: left inguinal hernia.

	Percentage of CO_2 in specimens taken.
Before operation ..	6·13
	5·8
	6·25
Second day after operation	5·78
	5·08
	4·5
	4·0
Seventh day after operation	5·93 .
	6·09

The two changes that may be noted in the readings on the second day after operation, as compared with the pre-operative, are that the CO_2 percentage after operation tends to be rather lower, and that after the first few readings its concentration rapidly diminishes. The reasons for these alterations are quite obvious. The abdominal muscles constitute the chief active expiratory agents, and, being interfered with by an incision, they are unable to express the air from the lungs so completely; with the result that dilution with tidal air takes place, and a lower reading is obtained. The progressive diminution of the post-operative readings may likewise be explained by the greater tendency of the injured musculature to tire.
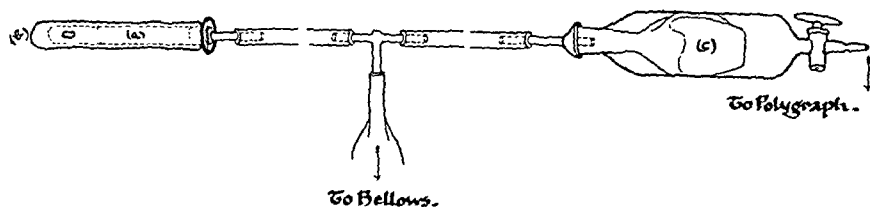
FIG. 296.—Diagram of apparatus used for investigating variations of intra-abdominal pressure. (*a*) is a glass tube with a lateral hole, surrounded by a rubber finger-stall. (*b*) By means of a bellows connected with the apparatus by a T-piece, the finger-stall can be distended after intrarectal introduction. (*c*) is a rubber balloon within a glass chamber, the further end of which is connected with a polygraph recording apparatus.

The Intra-abdominal Respiratory Variations of Pressure.—Finally, the effect of an abdominal incision on the respiratory variations of intra-abdominal pressure was considered. The apparatus shown in *Fig.* 296 was used for the investigation. The glass tube was introduced into the rectum, and the finger

stall distended. A curve of the variations of intra-abdominal pressure was obtained by connecting this to a polygraph recording apparatus.

In a normal individual breathing quietly, one finds a slight rise of intra-abdominal pressure with inspiration, and a fall with expiration. On deep breathing the respiratory undulations are similar but more marked. *Fig.* 297
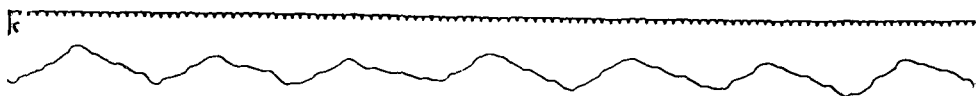
FIG. 297.—Tracing from normal patient showing variations in intra-abdominal pressure corresponding to respiration. The rise was associated with inspiration, the fall with expiration. Note the secondary curves due to the pulse, which in this case are well marked.

shows a typical tracing. In addition to this usual type of curve, one occasionally meets with a second type of curve in normal subjects breathing deeply, a well-marked example of which is illustrated in *Fig.* 298. It will be seen to consist of regularly alternating high curves (*a*), and smaller flatter curves (*b*). The upward stroke of (*a*) corresponded to inspiration, and so

FIG. 298.—Tracing of the intra-abdominal pressure of a normal patient showing a somewhat unusual curve. *a* is the ordinary rise and fall with inspiration and expiration, while *b* is a late expiratory rise due to a forcible contraction of the abdominal muscles after the diaphragm has ceased acting.

far the record resembles the previous one. The secondary (*b*) occurred during the latter part of expiration, and must be due to abdominal muscles of expiration continuing to act after the diaphragm had returned to its normal position, thus causing a further rise of pressure. That the secondary curve is a voluntary act, caused by the forcible expiratory straining, and not a part of ordinary reflex respiration, is shown by the fact that it disappears under anæsthesia (*Fig.* 299). Apart from these two types of normal curve, the only other
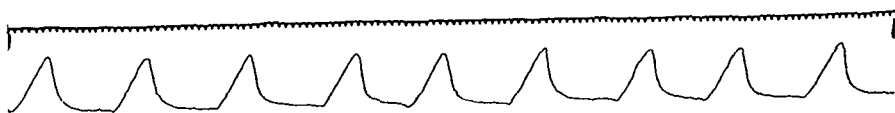
FIG. 299.—Curve of intra-abdominal pressure from same patient as in *Fig.* 298 while under the influence of a general anæsthetic. Shows automatic respiration, with no trace of curve *b*.

point of interest noted in the control subjects was that, in one patient with bronchitis and bronchial spasm, owing to his difficulty with expiration, the curve was reversed, a slight rise occurring with expiration rather than inspiration.

Having obtained a series of normal curves, a number of patients were studied before and after an abdominal operation, to determine the effect

produced by an abdominal incision. Occasionally no marked differences were noted, but as a rule quite definite changes in the curves were seen after operation, which may be summarized as follows : (1) The post-operative curve is less regular ; (2) The undulations of quiet respiration are diminished, and the amplification on deep breathing is much lessened as compared with before operation ; (3) The secondary curve of late expiration, if present before operation, is either greatly diminished or disappears.

Fig. 300.—Tracing of intra-abdominal pressure of the same patient as in *Figs.* 301, 302. Shows the irregular character of the respiratory variations in intra-abdominal pressure after abdominal operation.

Fig. 300 affords a particularly well-marked example of the results of an abdominal operation. A series of control experiments was performed on patients who had been submitted to the operation of radical excision of the breast for carcinoma, but no gross effect was produced thereby.

The Importance of the Respiratory Variations of Intra-abdominal Pressure.— The normal variations of intra-abdominal pressure with respiration must be an important mechanism in aiding the return of blood from the inferior vena

Fig. 301.—Showing artificial rises of intra-abdominal pressure produced by abdominal massage.

caval system of veins to the heart ; for the intra-abdominal pressure rises when the intrathoracic pressure is lowered, its positive pressure thus aiding the aspiratory effect of the negative intrathoracic pressure. If, as we have seen, an abdominal incision disorganizes this abdominal pump mechanism, a tendency to stasis in the great veins of the abdomen must result, a condition of affairs which it is always assumed predisposes to thrombus formation. In considering measures to counteract post-operative venous stasis, one may note

Fig. 302.—Showing action of abdominal massage in reinforcing the action of the abdominal pump mechanism if applied during deep inspiration only.

that it is quite easy by massaging the abdomen to produce a rise of intra-abdominal pressure. *Fig.* 301, which is from a patient seven days after the operation of appendicectomy, shows this, each undulation corresponding to a pressure of the hand on the abdomen. In order, however, that such abdominal massage shall reproduce the action of the normal abdominal pump mechanism and play its full part in aiding the venous return, the pressure

should not be applied irregularly, but during inspiration when the intra-thoracic pressure is lowered. *Fig.* 302 shows how, when applied in this manner, the respiratory undulations are reinforced. One may conclude from this that properly applied abdominal massage should be a measure of some value in combating post-operative venous stasis, and might be used to supplement the procedures ordinarily used for this purpose.

Discussion.—We have seen that in practically all abdominal cases investigated there must have been a certain deficiency of expansion of the lung bases, and a certain amount of venous stasis after as compared with before operation. In no instance did collapse of the lung or embolic complications occur, and the conclusion must be reached that any effect that respiratory sub-efficiency has in this connection is of a subsidiary or predisposing nature only, and that other factors of an exciting nature are necessary for the development of the complications. As stated early in the paper, this investigation started from the assumption that the reason for the special frequency of the above complications after abdominal operations was a mechanical one. This assumption may be incorrect, and it may be that the special liability of abdominal operations to be followed by pulmonary collapse and embolism depends, not on a mechanical factor, but on something of another nature. It is not proposed, however, to enter into this aspect of the subject here. A question more closely related to the present investigation is whether measures directed to restoring the efficiency of respiration reduce the incidence of these complications. A certain amount of evidence exists to suggest that such measures are of value, but much of the literature on the subject is unsatisfactory and inconclusive. It does seem reasonable, however, since abdominal operations are known to interfere with the efficiency of respiration, to endeavour to combat such interference. In the present state of our knowledge, measures directed to this end cannot be regarded as having a guaranteed prophylactic value, but such an investigation, if rigidly controlled, would constitute a useful piece of clinical research. As a result of this study, one would specially emphasize the importance of combating post-operative distension of the abdomen, owing to its effect on the diaphragm ; the value of a firm support in 'splinting' the injured abdominal musculature ; and the theoretical considerations in favour of the employment of abdominal massage after operation.

SUMMARY.

1. It is shown by references to the literature, and by personally collected figures, that thrombosis and embolism, and massive collapse and inflammatory affections of the lung bases, are more liable to be met with after abdominal operations than after surgical procedures in other parts of the body.

2. Acting on the theory that this special liability depends in some way on an interference with respiratory function, a study has been made of the effect of an abdominal operation on the mechanism of respiration.

3. The effect of an abdominal operation on the vital capacity, tidal air, movements of diaphragm, and the respiratory variations of intra-abdominal pressure, is shown.

4. The value of several suggested remedial measures is discussed.

5. It is concluded that any influence that interference with respiration has is of a predisposing nature only, and that other factors are also necessary for the development of the above complications.

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THE RADIUM PROBLEM.

II. RADIUM TREATMENT OF BUCCAL CARCINOMA.

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In the treatment of malignant disease in any site we are concerned with the primary growth, the immediate lymphatic drainage area, and more distant metastases, generally in the thorax or abdomen, either blood- or lymph-borne. Radium therapy at its present stage cannot pretend to deal with the last type, and although the treatment of the primary growth in buccal carcinoma is on a satisfactory basis, considering the limitations of the method, the problem in the lymphatic drainage area is by no means solved.

Theoretically, metastasis to the lymph-glands in buccal carcinoma may occur by embolism, by permeation, or by both, but at an early stage clinical evidence points to embolism as the method of dissemination. In a large number of recorded cases treated by various methods cures have resulted from the extirpation of the primary growth and secondary deposits as separate entities, no attention having been paid to the intervening lymphatics. If spread had occurred by permeation we should have to assume that the lymphatics had dealt with the contained malignant cells, and I am aware of no histological evidence in support of the theory of permeation. Squamous-celled carcinoma, indeed, in all situations appears to spread by embolism. In such sites as the hand or foot the secondary deposits are in the lymphatic glands, and no nodes develop along the paths of the lymphatics, which one would expect if permeation were the mode of spread.

There is, therefore, justification for dealing with the primary growth and the gland-bearing area as separate entities. The lymphatic glands are the natural means of defence against the spread of the disease in that they act as filters, and it is quite possible that they may be able to deal with malignant emboli just as they do with bacteria. It is therefore reasonable to attempt treatment of the primary growth first of all, and so remove a source both of sepsis and malignant embolism. If, for example, a unilateral block dissection—which by many is considered the best method of dealing with the lymphatic drainage area—is performed prior to the treatment of the primary growth, the lymphatic flow is diverted to the opposite side, and the glands there, which may previously not have been involved, may become so. The performance of a block dissection also interferes with the blood- and lymph-supply of the affected side, and this increases the tendency to radium necrosis. On all grounds, therefore, we feel that the primary growth should first be treated.

Diagnosis.—In Manchester it is almost invariably our practice to rely on the clinical evidence in making a diagnosis of buccal carcinoma. Of necessity, particularly before radium became recognized as a valuable therapeutic agent, a large number of the cases which were referred for treatment were recurrences after surgical operations. From a study of these I have been particularly impressed by the injurious effects of incomplete operations in malignant disease, and regard biopsy as such a procedure. The number of cases treated since the present technique was instituted is about 500, and there is ample evidence from a study of the material from the secondary deposits obtained from block dissections to prove the fact that in a large number of cases radium can cure primary growths in the mouth. · If a few cases are wrongly diagnosed, they can scarcely, with such a large number, affect the statistical position, and I feel that biopsy is a bad procedure in the interest of the patient. Mr. Geoffrey Keynes tells me that he has discontinued the procedure in treating breast carcinoma, for the reason that recurrence took place in the scar by implantation. Radium treatment is a conservative procedure in the mouth, and the position is quite different from that of the surgeon who proposes to perform a complete or partial glossectomy and who must be sure of his diagnosis.

Histology.— Although biopsy has not been practised, the material obtained from block dissections, which often form an integral part in the complete treatment of a case, has always been examined. In general the histological character of the primary growth is reproduced in the secondary deposits, and after a time it was evident that the microscopical characters
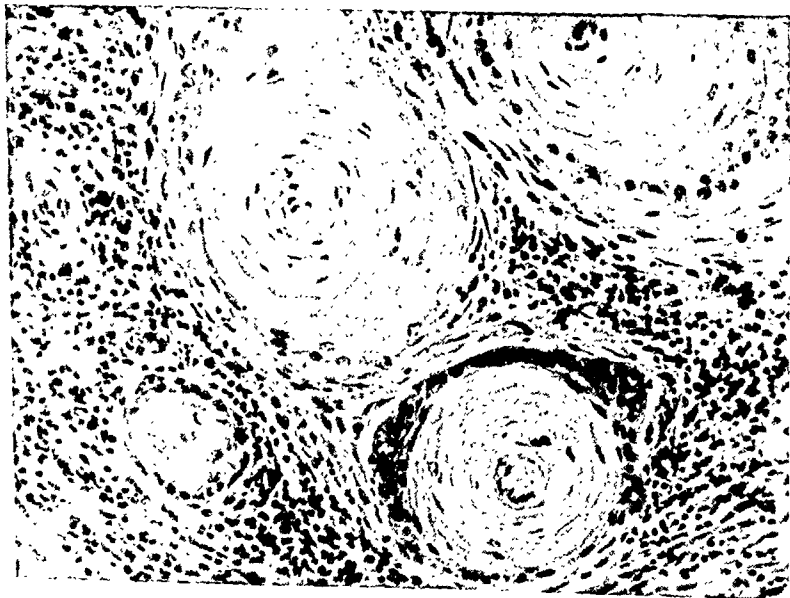
FIG. 303.—Squamous epithelioma of floor of mouth. This is an extreme case of differentiation. Correspondingly metastasis is often late, and in this particular case there was no clinical evidence of metastasis until three years after the primary lesion had been cured.
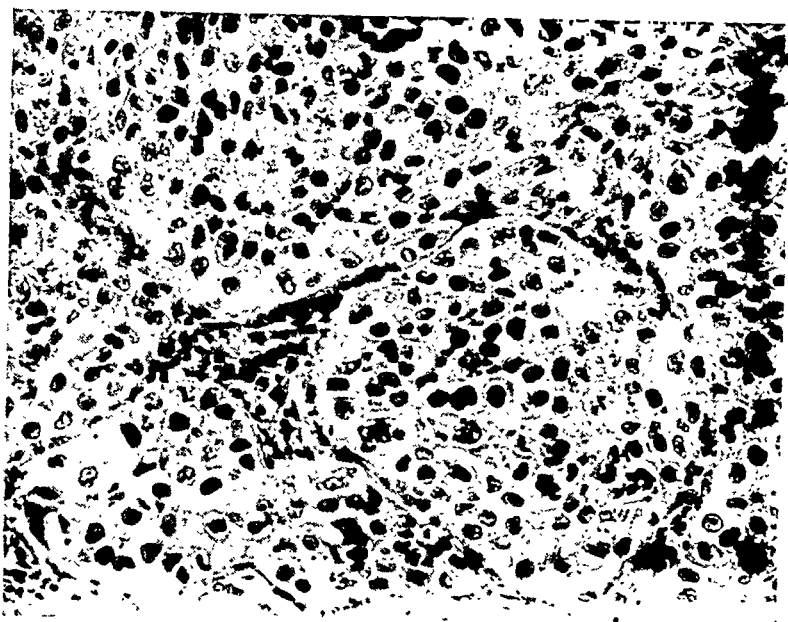
FIG. 304.—Undifferentiated squamous epithelioma. Base of tongue.
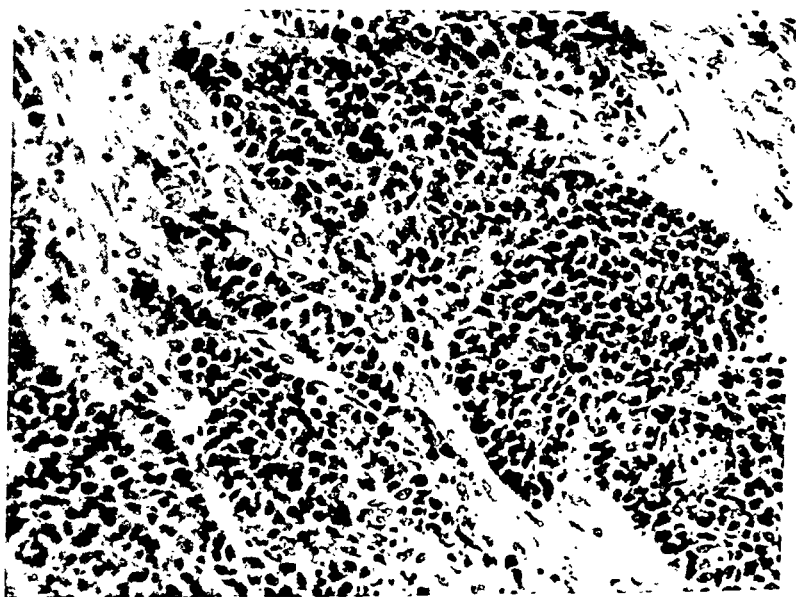
FIG. 305.—An undifferentiated squamous epithelioma of the middle third of the tongue. This resembles the type invariably met with at the base.

exhibited considerable variations. An attempt has been made to correlate these variations with the different sites in the mouth, and the observations from a large number of cases are as follows :—

1. *Buccal Surface of Cheek, Lips, Floor of Mouth, Infralingual Surface of Tongue, Anterior Third of Dorsum of Tongue, Alveoli.*—A highly differentiated type is observed in which cell-nests and keratinization are marked features. Corresponding with this, growth is not so rapid and metastasis is not so early.

2. *Base of Tongue.*—Almost invariably a highly cellular, undifferentiated, squamous epithelioma is observed, which resembles that found in the pharynx and cervix uteri. Cell-nests are rarely, if ever, found. Metastasis is early, and often occurs in the mediastinum, lungs, and even the liver. This type is extremely radio-sensitive.

3. *Middle Third of Tongue, Fauces and Tonsils, Uvula and Soft Palate.*— On the whole an intermediate type is found, in which keratinization is not so marked as in the first class. On the other hand, occasional highly keratinized and also highly cellular types are met with.

Microphotographs (*Figs.* 303–305) are reproduced to show extreme variations. All types respond to radium, but the most brilliant local results are often obtained in advanced cases at the base of the tongue ; such results are not procured in the anterior and more accessible parts of the mouth with equally advanced cases.

In an early series of 78 cases the sites of origin in the tongue were investigated : 52 (66 per cent) were in the middle third ; 16 (20 per cent) were in the anterior third ; 10 (12 per cent) were in the base.

The Evolution of Radium Treatment in the Primary Site.—This is an interesting subject, and, just as in nature development proceeded along different lines, by a process of elimination some uniformity of method has resulted. Naturally at first treatment was a process of trial and error, but Dominici first realized the importance of filtration, and the principle of the selective action of the γ ray.

Surface application was first tried with comparatively intense sources for short periods of time. If these are not filtered, β rays are given full play, but their effect is very localized and differs little from that of the cautery. The law of the inverse square, by which the intensity of the rays, whether β or γ, varies inversely with the square of the distance, also made this an unsuitable method except for very superficial types of growth. It is true that it is theoretically possible to increase the intensity at the surface so as to discount this effect at a depth, but the immediate effect around the source then becomes so intense as to produce necrosis or a burn.

Implantation of needles containing radium salts or emanation followed, and was first tried by Stevenson and Joly, of Dublin. Fairly intensive sources were used, but the principle of filtration so as to use only γ rays was not employed. Twelve to twenty-four hours were average exposures.

The war period undoubtedly retarded advances, but gradually the intensity of the implanted sources was cut down, and the time of exposure correspondingly increased. This was the foundation of the modern method of treatment for the primary growth in buccal carcinoma, and is largely due

to the work of Regaud, who combined this principle with the filtration advocated by Dominici. The American School at this period discarded filtration entirely, and implanted small capillary tubes of glass containing emanation, which were left in the growth. Some of these sloughed out, but some remained permanently in the tissues. Owing to the action of the β rays an intense reaction with necrosis and sloughing resulted, and, although many good results were obtained, many patients died from the sepsis, pain, and consequent exhaustion which often occurred. This method, sometimes combined with electro-coagulation, was used at the Manchester and District Radium Institute before the present technique, which was adopted at the end of 1925. An analysis of some 50 cases which were apparently cured for varying periods of from one to nine years showed that this principle of prolonged irradiation was responsible for 80 per cent of these apparent cures. The contrast between the severe reaction of the unscreened method of treatment and the uniformity of result and comparative painlessness of Regaud's method was to me dramatic. The result has been that rarely is a case treated without marked amelioration of symptoms even if a primary cure is not obtained, and this is reflected in the fact that a patient who has been treated seldom fails to attend again for examination when requested to do so.

TECHNIQUE.

Needles or Seeds ?—There is at the present time in this country a difference of opinion as to the advantages in the use respectively of needles and removable platinum radon seeds. In both, the external diameter is cut down to a minimum and the trauma from insertion is on this account negligible, but seeds have a relatively short active length—0·3 mm. is commonly used—whilst needles may vary between 10 and 30 mm. in length. The method of
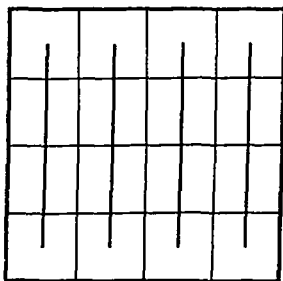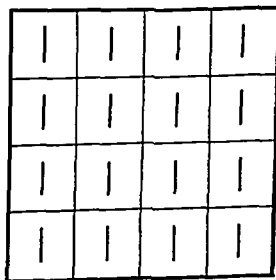
FIG. 306.   FIG. 307.

implantation, however, depends a great deal upon the skill of the operator, and, when a physical agent is being used which is constant in its action, we feel strongly that any method which tends to eliminate this variable human factor should, as far as possible, be adopted.

If *Figs.* 306, 307 represent a cross-section of an area to be implanted, then it is obviously easier to insert four needles each of active length 12 mm. than 16 seeds of active length 3 mm. As a practical illustration, we have personally used with success 20 needles each of active length 15 mm. in the

treatment of a buccal carcinoma, representing a total active length of 300 mm. We doubt whether the equivalent active length in seeds, which would require 100, could have been adequately spaced. Failure to implant accurately means that some part of the tumour is under-irradiated, leading inevitably to recurrence.

Filtration.—Personally we use a minimum filtration of 0·5 mm. of platinum, which allows about 0·4 per cent of β irradiation to pass into the tissues, and a maximum of 0·6 mm. of platinum. Practically all our radium element is put into cells of wall thickness 0·2 mm. of platinum, and these cells are contained in sheath needles of wall thickness 0·4 mm., giving a total filtration of 0·6 mm. The weak point in a needle is the seal between the trocar point and the body, and we consider that the use of cells gives twice as much protection against leakage due to trauma or the accidental contact of mercurial or iodine solutions with the gold seal.

Dosage.—It is often stated that a 'dose' of so many milligramme-hours is suitable for a case of buccal carcinoma; but this is a useless expression. If needles are implanted a certain distance apart, then obviously their number and the total amount of radium element or emanation used will vary with the size of the growth. Empirically we know that linear sources containing so much radium element or emanation can be inserted into normal tissues for corresponding time periods without harm, and the optimum relations of time and intensity are also known. The important points then in detailing technique are: (1) The linear intensity or the quantity of radium element or emanation contained per linear centimetre—the diameter of the source is reduced to a minimum and is a constant; (2) The screen or filter; (3) The time of exposure; (4) The number of sources used, and their active length; (5) The position of the sources, and their distance apart.

Active Length.—The active length of an implanted source refers to that part of the needle which contains radium salt or its emanation. In buccal carcinoma the most useful active length is 15 mm., but as a variable quantity it can be expressed as being between 10 mm. and 30 mm.

Our technique according to the above considerations is as follows:—

1.	Linear intensity	..	..	.. { 0·66 mgrm. radium element / 1·7 to 2 mc. of emanation
2.	Screen	..	..	.. 0·5 to 0·6 mm. of platinum
3.	Time of exposure		..	.. 7 to 12 days
4.	Active length	..	..	.. 10 mm. to 30 mm., but the commonest is 15 mm.
5.	{ Number of sources	..	..	.. Rarely exceeds twenty
	{ Distance apart	..	..	.. 1 to 2 cm.

Anæsthetic.—A general anæsthetic is given whenever possible, and our preference is for the intratracheal method. Palpation of the growth is essential, and the treatment of growths at the base of the tongue is considerably helped by forcible traction and bimanual palpation. We do not believe that this can be adequately performed under local anæsthesia. Almost invariably we find during the examination under general anæsthesia that the growth—if the tongue is involved, at any rate—is more extensive than the ordinary clinical examination reveals, owing to the intolerance of the patient. This should be remembered in estimating the number of needles.

Removal of Teeth.—Most authors stress the importance of removal of septic teeth before radium treatment is given. We cannot agree entirely, and think that it is a definitely bad procedure where the growth lies near or is in contact with the alveolar margin, as frequently happens in lesions which involve the floor of the mouth. Quite often a patient gives a history of a " sore place in the floor of the mouth " followed by a visit to a dentist with extraction of teeth. After this the condition, he says, became definitely worse, and we believe that rapid spread often occurs along the alveolar margin as a result. In cases where a sharp and carious tooth has been the main factor in the production of a carcinoma of the middle third of the tongue the extraction of this is beneficial, but personally I prefer to proceed with treatment rather than that delay should be caused by a widespread removal of teeth.

Fixation of Needles.—It is extremely important that needles be securely sutured, as otherwise—except where the base of the tongue is concerned—they will scarcely be retained for the full time period. There are various ways of doing this, and we have found the following method satisfactory.

(A) ANTERIOR THIRD OF DORSUM OF TONGUE.   (B) BASE OF TONGUE.

(C) SOFT PALATE.   (D) FAUCES AND TONGUE.   (E) MIDDLE THIRD OF TONGUE.
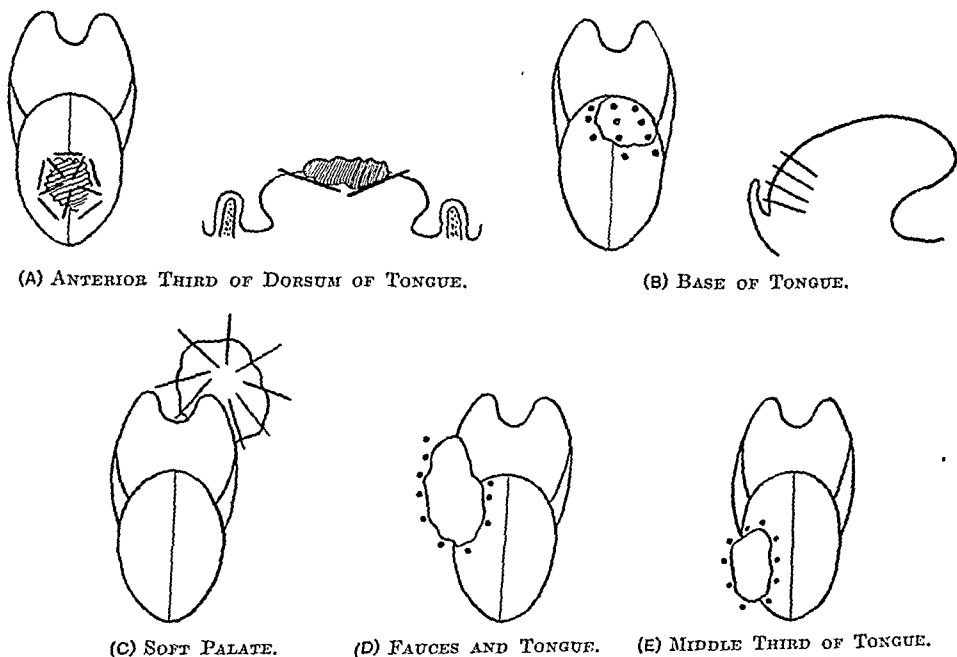
FIG. 308.—These diagrams indicate roughly a suggested arrangement of needles in various sites. As far as possible they are buried in healthy tissue parallel with the infiltrating edge of the lesion. An exception is the base of the tongue (B), where they are systematically implanted at right angles to the surface both in the tumour and in healthy tissue.

In the first place, stout silk thread is threaded through the eyelets of the needles before they are sent up to the theatre. The distal end is knotted, leaving a double length of about eight inches. A knot is then tied close to the eyelet hole, and through this is passed a piece of iodized catgut threaded in a Lane's half-circle palate needle. When the needle has been implanted

it is securely anchored by the catgut suture to healthy tissue if that is possible. As a rule, by the end of seven or eight days the catgut will have become partially absorbed and simple traction suffices to remove the needles. After all the needles have been secured individually the silk threads are gathered together and sutured, about one and a half inches from their attachment to the needles, to some part of the buccal mucosa. The ends are then brought out at the angle of the mouth, and fixed to the cheek with adhesive plaster. Any accidental traction on the silk threads will therefore not be transmitted to the needles.

Wherever it is possible needles are implanted outside and parallel with the infiltrating edge of the lesion, but with a large nodular growth, such as may be found in the tongue, they are also inserted into the lesion itself. They should not be placed close to bone if this can be avoided, as a troublesome necrosis may result; but if bone is invaded, then it is almost impossible to avoid this if a cure is to be obtained.

A few diagrams which illustrate the insertion of needles in various sites are shown in *Fig.* 308, A–E, but it is impossible to lay down any hard and fast rules. Experience and a careful examination of all patients after treatment are the main factors in success.

Element or Emanation ?—Personally we have not come to any definite decision with regard to the use of element or emanation. The former gives a constant intensity of irradiation, the latter one which diminishes by one-sixth per day. If a time period of eight days be taken, then, with a linear intensity of 0·66 mgrm. of radium element, the number of milligramme-hours per unit of length is $8 \times 24 \times 0.66$, or 127. If the initial linear intensity is 1·8 mc., then that at the end of eight days will be 0·45 mc., and the milli-curies destroyed 1·35, a quantity equivalent to 179 milligramme-hours. An initial intensity of 1·3 mc. per linear centimetre is physically equivalent to 0·66 mgrm. of radium element for a period of eight days. In practice, however, we have found 1·8 mc. to be a suitable strength, and there is the possibility that if the intensity should fall below a certain level no effect will be produced on the malignant cells. Russ[1] refers to the experimental proof of this.

We have a distinct impression at the moment that those cases of buccal carcinoma which have developed necrosis have occurred where radium element has been used, but the whole question will have to be analysed more carefully before any definite conclusion can be reached.

Notes on Technique in Various Sites.—

Tongue.—

Anterior Third of Dorsum.—It is extremely rare in our experience for an epithelioma to arise here except on a chronic specific glossitis. In such cases the nutrition of the tissues is not normal owing to an endarteritis and lymphangitis obliterans and the scars of healed gummata. The result is that the normal response is interfered with, and in some cases such epithelio-mata appear to be definitely radio-resistant. In other cases the lesion may disappear, but an indolent ulcer with sharply cut edges and a depressed base may persist, which takes a considerable time to heal. On the whole we are in favour of a prolongation of the time period to about ten days in these cases, with a screen of 0·6 mm. of platinum. Needles of active length 15 mm.

are suitable. Lymphatic spread is usually late here, probably owing to the tendency to obliteration of the lymphatics by the chronic inflammation of specific origin. (*See Figs.* 303 A.)

Middle Third.—These lesions usually start at the border of the tongue just anterior to the faucial pillar, and tend to spread into the substance of the tongue, on to the floor of the mouth, and on to the fauces and tonsil. We generally use needles of active length 15 mm. In the tongue they are inserted at right angles to the surface around the medial border of the lesion, whilst they are pushed horizontally backwards below the growth. If invasion of the fauces has occurred, they are placed horizontally and parallel with one another beneath the base of the ulcer. Sometimes such a growth becomes attached to the ascending ramus of the mandible, and it is then that necrosis of bone is almost inevitable. (*See Figs.* 308 D, E.)

Base.—It is almost impossible to suture any but the most anterior of the implanted foci here, and the growths are often so bulky that the needles have to be placed in the substance of the tumour. Luckily these growths are all of an undifferentiated and radio-sensitive type, and accurate implantation, though desirable, is not so necessary to obtain a good local result as in the more anterior part of the tongue. We always try to place equidistantly from 9 to 12 needles of active length 15 mm. in the base of the tongue irrespective of the apparent extent of the lesion. The tongue is drawn well forward, and, with a right-angled introducer, the needles are inserted at right angles to the surface (*see Fig.* 308 B). They have thus a slightly forward inclination, and accidental traction on the silk threads does not tend to displace them, as its direction is at right angles to the axis of insertion. Retention is aided by the relative immobility of this part of the tongue. A time period of 7 to 8 days is usually sufficient.

SOFT PALATE AND UVULA. — We prefer needles to seeds despite the difficulty of burying them, owing to the thinness of the tissues. With care and persistence and good anæsthesia the operation can usually be performed. In addition to the usual type of active length 15 mm., needles of 10 mm. active length will be found useful. (*See Figs.* 308 C.)

FLOOR OF MOUTH.—As a rule these lesions are superficial and needles can be inserted beneath their base parallel with the floor of the mouth. Needles of active length 10 and 15 mm. are usually employed.

CHEEK.—Implantation is, in our opinion, preferable to surface application, and can sometimes be performed through the external surface of the cheek, in which case the needles are more easily retained. An active length 15 mm. is suitable.

HARD PALATE AND ALVEOLI.—It is difficult to implant needles here, and some form of surface application is desirable. If these growths are seen at an early stage they are often superficial and tend to spread along the paths of least resistance, i.e., along the mucosa. A reference to *Fig.* 303 will give some idea of the form of the apparatus. Upper or lower plates are made of vulcanite, and the units of irradiation are contained in a box. Needles or tubes of suitable active length and standard linear intensity (0·66 mgrm.) are placed in the base and fixed about 1 cm. apart between two layers of adhesive plaster, which can be kept in position by packing

the interior of the box with cotton-wool. As the lesions lie close to bone the screen can with advantage be increased to 0·8 mm. of platinum, so as to cut out the γ rays of longer wave-length. The 'box' keeps the units of irradiation at a distance from the opposing alveolar margin, and is the best method of protection, remembering the effect of the inverse-square law

FIG. 309.—Diagrams to illustrate vulcanite plates which contain radium tubes for the treatment of growths involving the hard palate or lower alveolar margin. 0·8 mm. of platinum is used as a screen so as to absorb the γ rays of longer wave-length owing to the proximity of bone. In each case the units of irradiation are placed in a box between layers of adhesive plaster, the rest of the cavity being packed with cotton-wool. In the case of the palate this keeps the tongue and, in the lower alveolar margin, the upper alveolus, at a distance from the source of irradiation, and lessens the reaction and tendency to necrosis respectively. The intensity of irradiation varies inversely as the square of the distance.
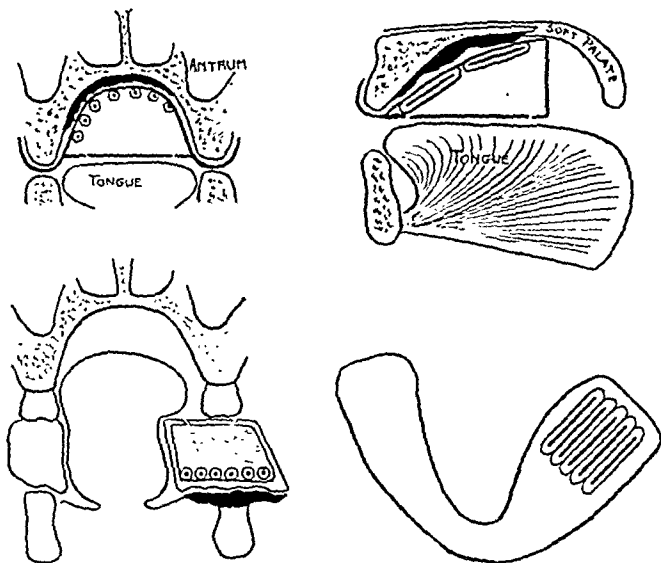
on the intensity of irradiation. Seven to eight days of irradiation will probably prove ample, and it is a good plan to change the position of the tubes, if this is possible, once or twice during the period. Probably more homogeneous irradiation is thus obtained.

Re-insertion.— In all the above situations in which the lesion is very extensive it is better to remove the needles at the end of five days, and re-insert under a general anæsthetic for a similar period of time. Errors of distribution at the first attempt are probably corrected to some extent, and we have found that extensive lesions can be more successfully treated. We regard this as a definite improvement in technique.

Protection of Bony Structures or Adjacent Soft Tissues.—It will probably have been noticed that no reference has been made to the wearing of lead plates over the alveoli or hard palate, as advocated by some authors. We have not found it necessary, and think that it puts too great a strain on the tolerance of patients, which must often have reached its limit. After all, 0·6 mm. of platinum absorbs all the β irradiation, whilst a mould composed of 1 mm. of lead will only absorb about 4 per cent of the total γ irradiation which strikes it.

AFTER-RESULTS OF TREATMENT OF PRIMARY GROWTHS.

Normal Reaction.—In few places can the reaction on a mucous surface be studied so well as in the mouth. By about the tenth day quite an appreciable change will be apparent. If the lesion should be a projecting one it

will have become considerably flattened, and for a variable distance around
the lesion of from 1 to 2 cm. the normal mucosa will be covered by an adherent,
greenish-yellow, fibrinous deposit, which is perhaps best compared with that
on the pleura of the lung of a patient dead of lobar pneumonia.   In the case
of a nodular lesion the treated area does not look unlike an infarct, and it is
curious that the line of demarcation between the reaction zone and the sur-
rounding mucous membrane is very sharply defined.   This becomes more

FIG. 310.—An infralingual carcinoma of the tip of the tongue.   The second drawing
illustrates a perfect reaction, in which the treated area is covered by a greenish-yellow
fibrinous deposit.   The edge is extremely sharply defined and the lesion now is not unlike
an infarct (fourteen days after removal of needles).   Six weeks later it is difficult to find
any trace of the original lesion, as shown in the lower figure.   Treatment : Implantation—
5 needles.   Active length, 15 mm.   Linear intensity, 2 mc.   Screen, 0·5 mm. of platinum.
Time, 10 days.

marked as time progresses, and especially if slight over-treatment has been
given.   At the same time any induration becomes less distinct and in three to
four weeks has disappeared, although the treated zone has still a different
consistence and feels firmer than the healthy tissues.   With a perfect response,
in six to eight weeks' time little or no trace will be found of the original
lesion.   Mobility will at the same time have returned to normal.   (Fig. 310.)

Abnormal Reaction. — Under-treatment is characterized by the fairly obvious feature of persistent induration, although ulceration may have disappeared.
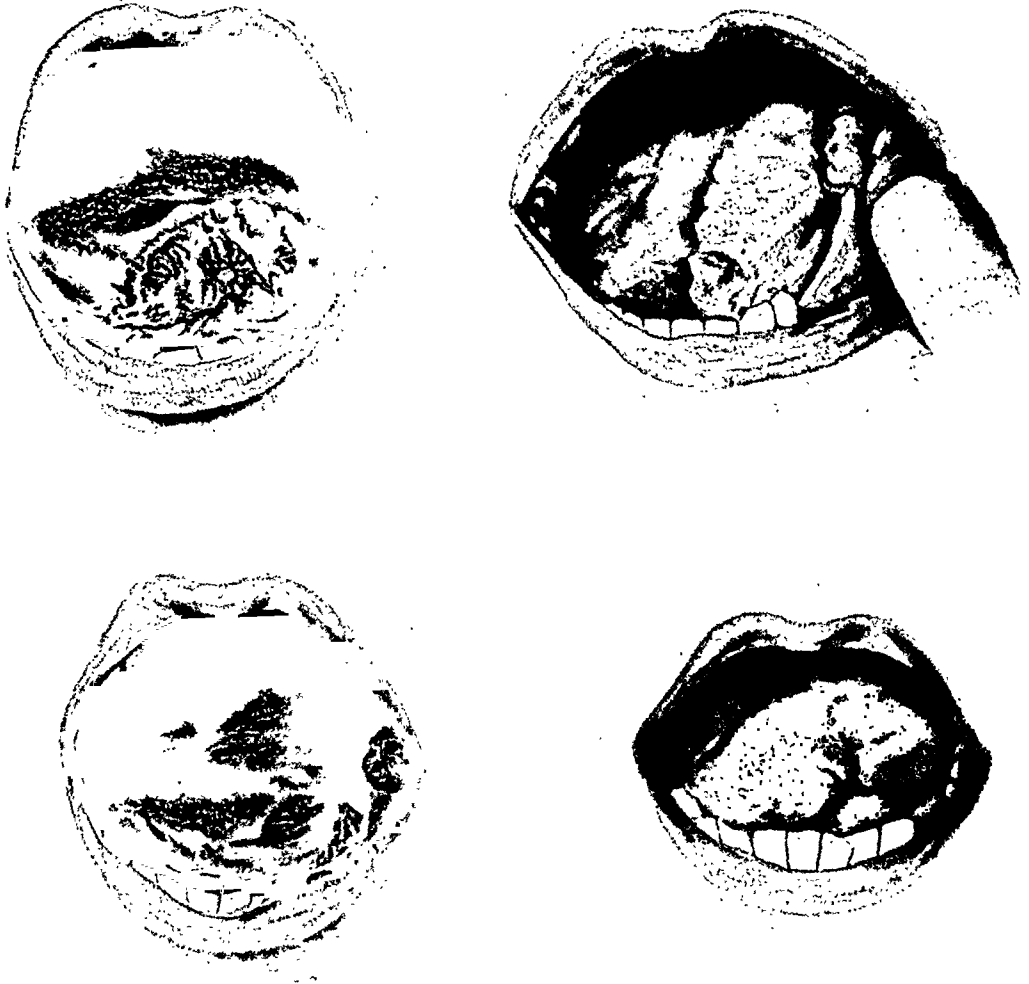
Fig. 311.—These drawings are from a case in which the reaction was slightly excessive. The second drawing was made nine days after the removal of the needles, and should be compared with the corresponding stage in *Fig.* 310. In the third a depressed ulcer is seen at the junction of the tongue and the floor of the mouth, eighteen days later. This took six weeks to heal, leaving a somewhat depressed and puckered scar. Treatment: Implantation—9 needles. Active length, 15 mm. Linear intensity, 2 mc. Screen, 0·5 mm. of platinum. Time, 9 days.

Over-treatment, leading perhaps to radium necrosis, often presents a difficult problem, and it is very probable that, before experience has been acquired, lesions so treated have received a second application under the impression that the growth has not been completely destroyed. This, of

course, only accentuates the condition, and from pain, sloughing, and consequent exhaustion from inability to sleep or take food the patient may succumb. Mild degrees of over-treatment are usually marked by the persistence of the fibrinous deposit to which reference has previously been made. Gross degrees show central ulceration of varying depths, and the edge of the ulcer is usually very sharply defined as though cut with a knife. The surrounding tissues are often œdematous and display a 'woody' type of induration. When the process has reached its maximum the base of the ulcer is covered by a very tough and adherent green slough. These ulcers are extremely painful and tender, and may take eight to twelve months to heal. A depressed scar results which causes puckering of the surrounding tissues and, if the tongue is the site of the lesion, may cause some limitation of mobility (*Fig.* 311). In some cases the ulceration has been so deep that a cul-de-sac lined by epithelium 5 to 10 mm. in depth, and perhaps 0·4 mm. in diameter, results. Necrosis of bone is sometimes met with when a lesion lies near to it, and this is particularly noticeable in the case of growths near the ascending ramus of the mandible and the alveoli. On the whole it is not very frequent, though some authors have advocated resection of the ascending ramus prior to irradiation of lesions involving the fauces. Naturally, when growth is definitely infiltrating bone, necrosis is inevitable. Certain workers advise protection of the lower alveolar margin and of the palate when tumours of the floor of the mouth and tongue respectively are being treated. In Manchester we have not found this to be necessary, nor does it appear reasonable to expect a mould composed of 1 mm. of lead, which only absorbs a minute percentage of γ rays, to protect these structures efficiently. The secondary β irradiation is absorbed by the tissues in which the needles are buried. As stated above, wearing of such apparatus is putting a good deal of additional strain on the tolerance of a patient, which must often have reached its limits already.

Bronchopneumonia. — The only noteworthy immediate complication of treatment is a bronchopneumonia, which we have found in two or three patients treated out of a total of 400. This is a relatively small number taking into account the oral sepsis and enfeebled condition of so many of the patients of the hospital class.

Hæmorrhage.—Severe hæmorrhage was noted in one of our own series whilst the needles were *in situ*. It was probably the result of ulceration through the wall of the lingual artery, and was easily controlled.

Late Necrosis.—Occasionally where a thick scar results—i.e., in those cases which have already been overtreated—ulceration may occur in the centre a year or more afterwards. It is probably due to a progressive endarteritis obliterans, and the breaking down is caused by some temporary superimposed effect, e.g., trauma or friction. Its occurrence in the centre of a lesion a considerable time after treatment, its comparatively rapid onset, the fact that it does not bleed, and that it is immediately lined by a tough, adherent slough, should lead to its detection. Naturally the possibility of recurrence should be borne in mind and the patient kept under close observation, but local recurrence a year or more afterwards is extremely uncommon if a high standard is observed in the assessment of a primary cure.

We have recently seen a case of necrosis of the mandible three years: after the primary growth was treated and cured. Two applications were given to the primary growth, an ulcer persisting after the first treatment, which through our inexperience was not recognized as being due to over-treatment. The original lesion was in the middle third of the tongue anterior to the fauces.

TREATMENT OF THE LYMPHATIC AREA.

When the primary lesion has been adequately dealt with, the treatment of the gland-bearing area has to be considered. When all the possibilities of spread are visualized, it will be realized that, no matter whether the original focus involves one or both sides of the mid-line, the area to be covered is a very extensive one. On theoretical grounds external irradiation at a distance would be ideal, but facilities are rarely available for it. The compromise of multiple foci near the skin has not yet shown that it is efficient, at any rate when palpable nodes exist. Finally, implantation would involve such an accurately spaced insertion of a very large number of needles that it would in itself be an almost impossible procedure, and with the surgical exposure necessary a block dissection might as well be performed.

There are three main types of case: (1) Those in which there are no palpable glands; (2) Those in which there are palpable glands, either unilateral or bilateral, and sufficiently mobile for a radical surgical removal; (3) Those in which there is unilateral or bilateral glandular involvement too fixed for surgical removal. Opinion varies a good deal as to the procedure in these cases, and the time has scarcely arrived when dogmatism is possible.

1. *Cases in which there are No Palpable Glands.*—It should be remembered that in certain cases metastasis never occurs, or, if it has done so, the lymphatic glands have dealt adequately with the malignant emboli. Surgical opinion would on the whole favour a block dissection if the lesion were unilateral, but opinion would by no means greatly lean towards a bilateral block dissection, owing to the severity of the procedure even when carried out in two stages. Probably the most conservative method is to irradiate both sides of the neck by multiple foci placed at a distance of about 2 cm. from the skin, as advocated by Cade in this country. The technique will be described later. Afterwards the patient is examined at monthly intervals, and a block dissection carried out should palpable nodes appear later.

2. *Cases with Palpable but Mobile Glands.*—Where palpable glands are present a block dissection should be carried out on the affected side. If both sides are involved a double block dissection should be done, with an interval of two to three weeks between the two operations, but the internal jugular vein should be removed on one side only. Probably the best radiological procedure is to follow this up a fortnight or so later by a prolonged external irradiation on the lines indicated in Class 1, but of course this is not an economical procedure with regard to beds or radium, and much will depend on local conditions and resources. It has been the practice in Manchester to implant from 10 to 15 needles of active length 15 mm., screen 0·8 mm. of

platinum, linear intensity 0·6 mgrm. radium element or 1·8 mc. of emanation, for seven days, in the wound but nothing like the same degree of homogeneous irradiation is achieved as by external irradiation, and of course the chances of sepsis are increased. Probably it is a sound procedure in all cases to implant a few needles close to the base of the skull, particularly when the primary lesion involves the fauces, lateral pharyngeal wall, or middle third of the tongue, as external irradiation is less likely to prove effective at this depth.

3. *Cases with Fixed Glands.*—It is doubtful whether external irradiation as commonly practised has ever 'cured' (in the five-year sense) a patient with fixed deposits in the neck secondary to a buccal carcinoma. Undoubtedly regression occurs, but so does recurrence, and the process cannot be repeated indefinitely, owing to the intolerance of the skin and to the immunization which follows non-lethal doses.

It is recognized that this question of immunization is not fully settled. However, if recurrence takes place in an area which has been irradiated, growth is often slower, and a fibro-neoplastic mass is formed, which is definitely more resistant to treatment. This may be due to the condition of the stroma. If irradiation is pushed, say, by a prolongation of the time period, the growth may disappear, but radio-necrosis is extremely probable.

Cade states that good palliative results follow the removal of as much of the growth as is possible surgically, combined with post-operative external irradiation, pushed to such an extent that the skin completely peels. In Manchester, this type of case, if not too advanced, has been treated exactly on the same lines as the primary growth, by implantation, and this is certainly worthy of trial if the palpable mass is limited to one group of glands.

If implantation is decided upon, incisions are made and flaps turned back as for a block dissection, and if the fixed glands are in the submaxillary or upper deep cervical groups, the sternomastoid is divided above the clavicle and reflected upwards. In this way a very good exposure of the anterior and posterior triangles of the neck is obtained, and accurate implantation is more easily performed. Usually needles are left *in situ* for a week, and removed under general anæsthesia. *Fig.* 312 is a diagram illustrating the implantation of needles in the wound after a block dissection has been performed. It is suggested that 0·8 mm. of platinum be used as a screen, so that only γ rays of short wave-length are employed. Concentration of needles is directed to the group of glands which is most involved. Probably post-operative irradiation by multiple sources on a 'collar' is preferable, but the method has advantages where large numbers of cases are being treated and supplies of radium are limited.
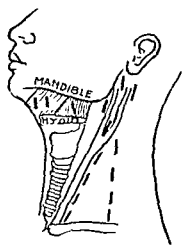
Fig. 312.—Illustrating the implantation of needles in the wound after block dissection.

Block Dissection.— No half measures should be adopted if surgery is decided upon. The removal of the internal jugular vein, together with the sternomastoid, is essential if a complete clearance of the gland-bearing area

is to be made. Not only does it enable this to be accomplished, but by giving better exposure it accelerates the operation. Regional anæsthesia or general anæsthesia is employed according to the preference of the individual surgeon, but it would appear that the former method might be carried out more frequently in view of the severity of the operation, and the fact that so many of the patients are over sixty years of age. If a block dissection is done on both sides, the internal jugular should be removed on the more affected side.

External Irradiation.—Cade recommends a Columbia paste collar 15 mm. in thickness. On it, and screened by 1 mm. of platinum or its equivalent in other metals, are disposed multiple foci containing 1·33 to 2 mgrm. of radium element and linear intensity 0·66 mgrm. In all about 50 to 70 mgrm. of radium element will be required. For post-operative irradiation seven to ten days' exposure for each side is about the average, but where the incomplete surgical eradication has been performed fourteen to twenty days' exposure will probably be required. It is impossible to be quite so definite with this method as with the primary site in detailing technique.

In prophylactic post-operative irradiation desquamation of the skin is the aim, but in the third class with fixed, inoperable deposits complete peeling is desirable.

From the above considerations it will be obvious that the purely radiological treatment of the lymphatic drainage area is not on a satisfactory basis. We feel that this is largely due to restricted supplies of radium and to the method employed. (If we consider the theoretical principles underlying treatment, implantation and surface application have considerable disadvantages.) Expediency must necessarily weigh most in the treatment of the individual; but the ideal method which must be tried, in the hope that greater quantities of radium may be forthcoming, is the employment of a large quantity of radium at a distance, which discounts both the human element and the physical disadvantages of current methods.

RESULTS OF TREATMENT.

The results of treatment vary as one considers the primary lesion only or the cases as a whole.

There are no five-year figures available in this country, but Continental workers report about 45 per cent of five-year cures as regards the primary site, and 20 per cent of absolute cures. When one takes into account the fact that all cases treated are reckoned, and that a large proportion were hopelessly advanced at the very beginning, these are remarkable figures. It is particularly pleasing, too, that the percentage of recurrences at the primary site is very small, if a high standard is set with regard to cases deemed 'cured'.

The functional results are almost perfect, especially in the tongue. Mobility is scarcely impaired, and only slight defects are noted when the tongue is protruded fully. In general, if the lesion is unilateral, the tongue is deviated as a whole to the side of the lesion, and the tip points to the opposite side (*Figs.* 313, 314).

Even as a palliative procedure for the primary growth radium has amply justified itself as a therapeutic measure. The end of those patients who die of an untreated and unchecked primary growth is most distressing; death from metastatic complications is comparatively peaceful.

FIG. 313.—Photographs showing the good functional results after treatment. They were taken in March, 1928, and were selected only for the reason that the patients resided locally. All except one patient, who died of intercurrent disease, are still alive and well. A minor point of clinical interest is that, with a unilateral lesion, the tongue as a whole is drawn towards the affected side, whilst the tip points in the opposite direction. Before treatment the tip usually points to the same side as the lesion. In five of these cases there was microscopical evidence of deposits in the lymphatic glands. (*Reproduced by kind permission of the Editor of the ' Lancet '.*)

The table on p. 516 has been taken from an article by Regaud in the *American Journal of Roentgenology and Radium Therapy*, vol. xxi, January.

1929, No. 1. Unfortunately this does not give a true view of the situation, as percentage figures for all cases treated between 1920 and 1926 are given. The year 1922 is that on which the latest five-year figures can be based.
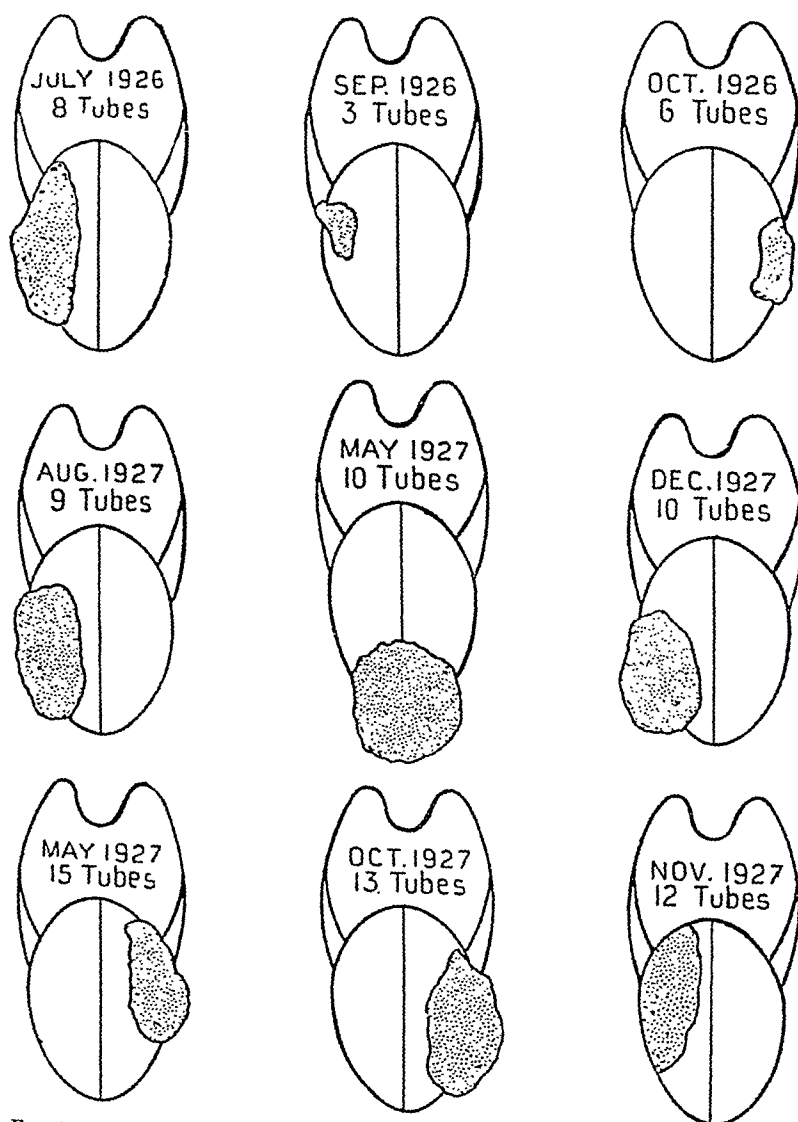
FIG. 314.—Key to the photographs shown in *Fig.* 313. All were moderately advanced cases with the exception of 2 and 3. (*Reproduced by kind permission of the Editor of the* 'Lancet'.)

The following table, which has been compiled from the one overleaf, gives the percentage figures for complete cure as assessed at the end of December, 1927 :—

		1922	1923	1924	1925	1926
Total	..	33	54	55	60	54
Complete cure	..	6	10	11	17	21
Percentage ..	..	18·18	18·50	20·00	28·33	38·88

CANCERS OF THE TONGUE AND OF THE FLOOR OF THE MOUTH. TOTAL STATISTICS OF TREATED CASES AND RESULTS, 1920–6.

(Revised Dec. 31, 1927.)

	1920	1921	1922	1923	1924	1925	1926	TOTALS	PERCENT-AGE
Number of treated cases ..	55	41	35	56	59	65	56	367	
Cases which were eliminated..	2	6	2	2	4	5	2	23	
Cases retained for statistics ..	53	35	33	54	55	60	54	344	
1. Anterior dorso-lingual localization	20	22	19	24	34	39	27	185	
a. Complete cure	5	6	3	6	9	9	11	49	26·4
b. Cure of local lesion of tongue. Death from secondary adenopathy ..	6	7	8	10	7	4	4	46	24·8
c. Failure to arrest primary lesion of tongue ..	9	9	8	8	18	26	12	90	48·6
Permanent arrest of primary localization taken by itself	..	..	..	..	..	..	..	95	51·3
2. Posterior dorso-lingual localization	16	5	6	18	14	12	11	82	
a. Complete cure	1	2	3	1	2	3	4	16	19·5
b. Cure of local lesion of tongue. Death from secondary adenopathy ..	2	0	0	5	4	2	1	14	17·0
c. Failure to arrest primary lesion of tongue	13	3	3	12	8	7	6	52	63·4
Permanent arrest of primary localization taken by itself	..	..	..	..	..	..	..	30	36·5
3. Infra-lingual localization ..	17	8	8	12	7	9	16	77	
a. Complete cure	0	3	0	3	0	5	6	17	22·0
b. Cure of local lesion of tongue. Death from secondary adenopathy ..	3	2	0	1	2	0	1	9	11·6
c. Failure to arrest primary localization	14	3	8	8	5	4	9	51	66·2
Permanent arrest of primary localization taken by itself	..	..	..	..	..	..	..	26	33·7
4. All localizations combined..	53	35	33	54	55	60	54	344	
a. Complete cure	6	11	6	10	11	17	21	82	23·8
b. Cure of local lesion of tongue. Death from secondary adenopathy ..	11	9	8	16	13	6	6	69	20·0
c. Failure to arrest primary lesion of tongue	36	15	19	28	31	37	27	193	56·1
Permanent arrest of primary localization taken by itself	..	..	..	..	..	..	..	151	43·8

From these figures it appears that if a patient survives three years without recurrence there is a reasonable chance of permanent cure.

In Manchester our figures for 1926, 1927, and 1928, which correspond practically with those for 1924–6 in Regaud's series, are as follows :—

			1926	1927	1928
Complete cure ..		..	18	25	51
Total ..	..	..	80	74	113
Percentage	..	..	22·50	34·7	45·13

These figures include all localizations in the mouth : Regaud's figures include only the tongue, infralingual surface of the tongue, and floor of the mouth.

I am indebted to Miss D. Davidson for the coloured drawings in the text.

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EXAMINATION OF MATERIAL REMOVED AT FIRST OPERATION.—The tumour masses were of a firm consistency and presented a greyish-white appearance, with many areas of hæmorrhage. Microscopically the sections show masses of small round or polyhedral cells, separated by fibrous tissue septa, and interspersed with small areas of hæmorrhage (*Fig.* 317). Under a higher
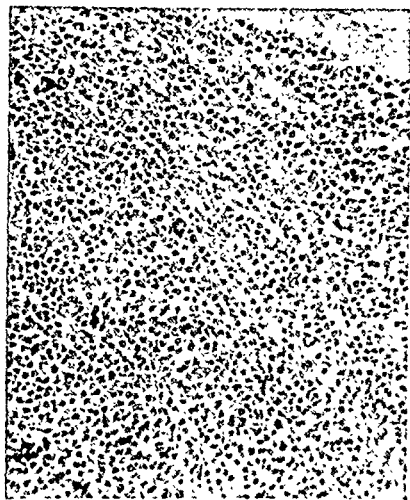
FIG. 317.—Low-power photomicrograph of tissue removed at first operation, showing general arrangement of tumour cells.
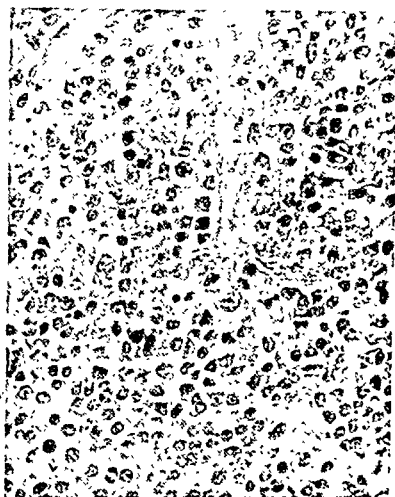
FIG. 318.—High-power photomicrograph of tumour, showing typical cell appearance and scanty stroma.

magnification (*Fig.* 318) the cells are on the whole discrete and separated from each other by a scanty matrix, but exhibit a tendency to form short columns.

FIG. 319.—Material removed at second operation, consisting of granulation tissue, with round-cell infiltration and islands of plasma cells and lymphocytes.

They are polyhedral in shape, and possess a round or oval nucleus situated eccentrically. The cytoplasm of the cells is amphophilic and non-granular ; and the nucleus, staining well with hæmatoxylin, is of a typical ' cart-wheel ', or ' clock-face ', type. Few mitoses are seen and no multinucleated cells. A few of the cells show degenerative changes, such as swelling, vacuolation, loss of nuclear outline, and disappearance of the nucleus. Staining with the Unna-Pappenheim method is typical, and a diagnosis of myeloma of plasma-celled type was made.

A blood-count showed only a mild secondary anæmia, with no abnormality in the red or white cells. No Bence-Jones proteosuria could be demonstrated. X-ray examination of the skeleton did not reveal any other foci of tumour formation.

EXAMINATION OF MATERIAL REMOVED AT THE SECOND OPERATION.—
The portions of tissue removed from the cavity vary slightly from a structure-
less matrix to well-formed fibrous tissue and vascular granulation tissue.
Islets of plasma cells, lymphocytes, and small round cells are found in most
of the sections, but there is no structural resemblance to the tumour forma-
tion originally present (*Fig.* 319).

EXAMINATION OF THE MATERIAL REMOVED AT THE THIRD OPERATION.—
The material appears to be entirely necrotic except for areas of fibrous tissue
containing chronic inflammatory cells.
There is no histological evidence of new
growth.

APPEARANCE OF THE FEMUR AFTER
AMPUTATION (*Figs.* 316, 320).—The speci-
men consists of the lower three-quarters of
the right femur. In the middle third of the
shaft there is a fusiform swelling measur-
ing 4½ in. long and 2¼ in. at its greatest
diameter. This enlargement is formed by
a shell of bone, in some places no thicker
than parchment, constituting the walls of
a cavity originally occupied by the new
growth of the marrow, and now devoid of
contents. In some places the bony shell
appears to have been perforated, the peri-
osteum alone forming the capsule of the
growth at these points.

On the antero-external aspect the
soft tissues, including the partially healed
skin incision, have been left adherent to
the margins of the cavity from which the
tumour was removed. The shaft of the

FIG. 320.—The lower two-thirds of the femur after amputation, showing fusiform swelling and original incision through the soft tissues.

femur above and below the bony swelling is normal in size and structure.

COMMENTS.

While multiple myeloma of plasma-celled type is of comparatively
common occurrence, cases showing one solitary focus of new growth appear
to be very rare. Aschoff[1] refers to cases recorded by Kunosoki and Frank.
Kolodny[2] (1927) states that only one case is recorded in the Registry of Bone
Sarcoma of the American College of Surgeons, and Ewing[3] (1928) does not
refer to their occurrence in his *Neoplastic Diseases,*. Shaw[4] (1923) has pub-
lished an account of a case which was completely cured by bone-grafting
after excision of the segment of bone affected by the new growth. Stewart
and Taylor[5] (1928) investigated a number of cases of plasmocytoma ; in one
case a second focus of growth appeared in the frontal bone after the original
myeloma had been removed from the maxilla, and disappeared under X-ray
treatment.

The solitary plasma-celled myeloma is a new growth which arises in the

bone-marrow, and appears to occur more frequently in the long bones than in flat bones or vertebræ. The origin of the tumour is still a matter of dispute ; the type cell is believed to be derived either from a lymphocytic cell or from the perivascular endothelium.

Ewing's sarcoma may be mistaken for myeloma when sections are overstained with hæmatoxylin (Kolodny, 1927), and plasma cells may be found in these tumours. Ewing's sarcoma, however, is an endothelial tumour, and, according to Ewing[6] (1924), is probably derived from perivascular lymphatic endothelium.

In the case of plasma-celled myeloma recorded in this paper the histology of the reparative process after removal of the new growth is of interest, especially regarding the use of radium. It seems probable that the use of radium in large doses has brought about a condition of ' radium necrosis ', which has not only prevented any attempt at recurrence on the part of the tumour tissue but has placed the natural reparative reactions of the healthy structures in abeyance. The possibility of such an eventuality must evidently be kept well in mind when radium is employed, as the clinical evidence of the necrotic influence may be delayed for ten days or a fortnight.

I am indebted to Mr. Hey Groves for permission to make full use of his clinical notes, to Dr. A. L. Taylor for his help and advice in the investigation of the histological material, and to Dr. G. B. Bush for the skiagram.

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THYROID METASTASES IN BONE.

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THE subject of this paper is an extremely controversial one, to be approached only with an open mind and in a spirit of inquiry. Its importance, however, can scarcely be denied, touching as it does on the vital question of whether or not benign tissues can disseminate. According to most accredited pathologists, dissemination is a feature of malignant tumours and of these alone ; but to challenge accepted views is sometimes instructive and is always of interest. It is a truism that no convincing definition of malign, as opposed to innocent, tumours exists ; and, in place of a definition, we have to content ourselves with mere tabulated lists of characteristics supposed to be pathognomonic of the two classes of neoplasm.

My interest in thyroid osseous metastases has recently been quickened because within the past two and a half years I have encountered two such cases in Tanganyika Territory.

CASE REPORTS.

Case 1.—An African woman, age about 50 years, was admitted to Songea Hospital (situated about one hundred miles from Lake Nyasa) on Sept. 2, 1926. She had a large, soft, fleshy lump on the back of the left side of the head ; it was adherent to the skin and covered with a network of enormously dilated veins. She complained of considerable pain in the region of the lump ; there was no enlargement of the cervical glands. There was a small, hard, apparently completely encapsuled lump, of about the size of a walnut, in the right lobe of the thyroid gland ; it had no features suggestive of malignancy, and the patient, though aware of its existence, had thought it too trivial to bring to my notice. She said that her thyroid lump had first appeared about three years previously and that the cranial lump had begun to develop about one year later. The latter had been of very slow growth. When seen by me it was the size of a very large orange. I tried to obtain a wedge of the tumour for section, but hæmorrhage was so furious that I had to abandon the attempt. The tumour was thus of an intensely vascular nature.

In the usual manner of Tanganyika natives, my patient, when she realized that there was no likelihood of a sudden and dramatic cure being produced, soon absconded from hospital.

It may be objected in this case that the cranial tumour may have been a primary malignant growth, the thyroid swelling being merely a coincidence. It is unlikely, however, that a primary malignant tumour of the skull could have existed for two years without at least fungating.

Case 2.—An African woman, of the Mkami tribe (Morogoro district), age about 45 years, was admitted to the Sewa Hadji Hospital, Dar-es-Salaam, on Feb. 21, 1929, complaining of a large and painful lump on the back of the head of three years' duration. There was a fleshy mass about the size of an ostrich's egg projecting

from the occipital region of the skull (*Fig.* 321).   It was apparently fixed to the sub-jacent skull and the scalp could not be moved over it.   There were dilated veins in the overlying skin.   Further examination revealed that there was a hard and slightly nodular lump (of hen's egg size) in the left lobe of the thyroid gland.   This lump was freely movable on the deep structures and was quite unattached to the skin ; it rose and fell freely on deglutition.   Apart from its hardness and its slightly nodular surface, it had no features of malignancy whatever.   In the right subclavian triangle I found a hard and somewhat fixed gland of about walnut size ; but apart from this no enlargement of the cervical glands could be detected.   The patient apparently attached no importance whatever to her neck condition, and could scarcely conceal her impatience when I examined it and questioned her about it.   She said that she had had a lump in her neck ever since childhood, but that it had never caused trouble.   She could not say that this lump had recently been increasing in size.
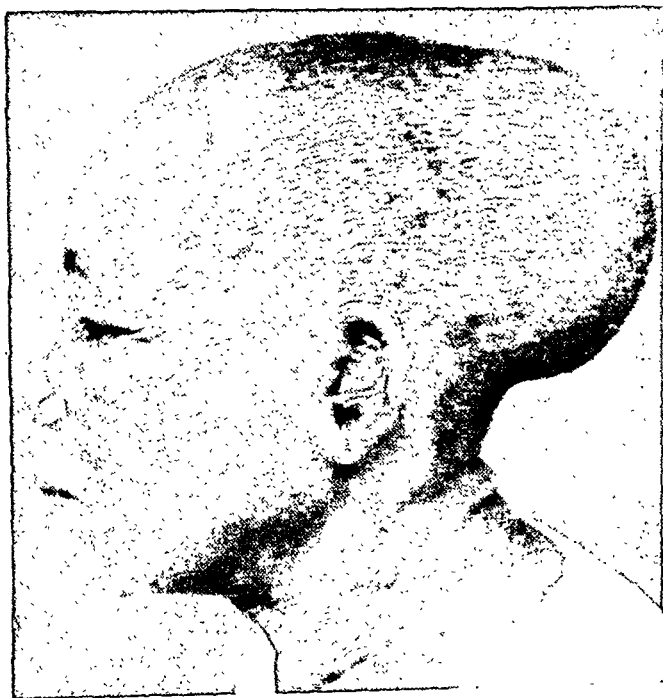
FIG. 321.—*Case* 2.   Appearance of the tumour.

Mr. J. E. Brunnen, of the Electricity Department, very kindly radiographed the skull for me.   The X-ray picture shows that the outer table, diploë, and a part of the inner table of a considerable portion of the occipital region of the skull had been destroyed and replaced by growth (*Fig.* 322); expansion had, however, been chiefly at the expense of the outer table.

On March 18, I removed a wedge of the tumour for section.   The growth had an appearance as of encapsulation, but as the 'capsule' was extremely hard and difficult to cut, I formed the impression that it was really the thinned-out relic of the outer table of the skull.   The tumour itself was extremely pale and of a rather waxy appearance.

This patient followed the example of the previous one in absconding from hospital before the condition could be further studied.   There was, in any case, little to be done for her.   Excision of the tumour would have entailed removing the whole of the occipital region of the skull.

FIG. 322.—*Case 2.* Radiograph showing destruction of part of the occipital region of the skull.
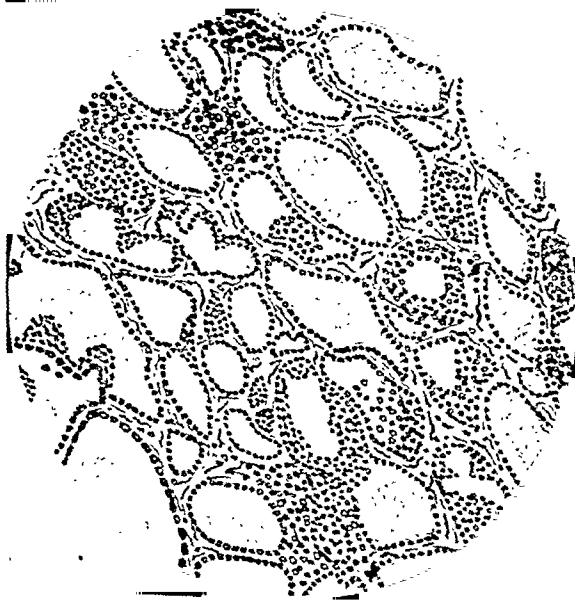
FIG. 323.—*Case 2.* Microscopic appearance of tissue removed.

Dr. H. O'D. Burke-Gaffney, of the Dar-es-Salaam Laboratory, examined the portion of tissue which I had removed. His report was as follows :—

" The structure of the tumour mostly resembles the type of fœtal adenoma. There are numerous empty tubules, surrounded in part by a vascular stroma. Some of these are dilated and contain secretion. In other parts there are irregular acini containing true colloid. Between these in some areas are masses of cuboidal cells which do not form acini. The tumour would appear to be an adenocarcinoma—subsequent to a fœtal adenoma which has developed malignant changes. Such a diagnosis is made chiefly from the metastatic nature of the growth. The essential histological changes mostly resemble both simple and fœtal adenomata. It would be difficult to identify a carcinomatous element from the appearance only." (*Fig.* 323.)

GENERAL FEATURES.

The occurrence, in or on bones, of tumours containing thyroid tissue has long been recognized, but the nature and origin of these deposits have given rise to much speculation. That they can occur as 'orthodox' metastases in cases of unequivocal thyroid cancer is undoubted, Pemberton[1] assessing the incidence at 6 per cent, while Ewing[2] holds that cancer of the thyroid is second only to that of the breast and prostate in the production of skeletal secondaries. Their relation, however, to the phenomenon of 'general thyroid malignancy' at once presents us with a problem which has never yet been solved. That tumours structurally identical with the thyroid gland can appear in the bones of patients whose thyroids are, judged clinically, either normal or else the seat of a simple growth or goitre, is a fact not easily explained ; and what Jacobson[3] has called 'the mysterious malignant adenoma' has so far baffled pathology. However produced, these deposits are oftenest found in women of from 40 to 65 years of age.[3]

The skull bones are the commonest sites for these growths, but they have also been found in the sternum, vertebræ, ribs, humerus, femur, pelvis, and clavicle, and approximately in that order of frequency.[2] Thyroid 'rests' or inclusions may possibly explain a few cases, but it is a fact that the bones least likely to contain aberrant thyroid tissue are the ones most commonly attacked by 'metastasis', and even the clavicle and sternum are developed in a plane altogether anterior to that of the thyroid *Anlage*.

Thyroid metastases make their first appearance, as a rule, in the vicinity of the cranial sutures or of the epiphyses of the long bones.[2] They may be encapsuled or diffuse, endosteal or periosteal, and they are sometimes osteoplastic, so that a pathological fracture due to their presence may ultimately unite.[2] They have often been mistaken for primary sarcomas of bone.[2] Some are pale and almost bloodless (as in *Case* 2), while others are so intensely vascular and display such vigorous pulsation that they have been mistaken for aneurysms. Cramer was thus misled by a sternal deposit, which he treated by ligature of some of the great vessels. (*Case* 1 was intensely vascular, but it did not pulsate.) Many of these deposits function after the manner of the thyroid gland—for example, in one of Eiselsberg's cases, ' tetany' (? cachexia strumipriva) followed the removal of a carcinomatous thyroid, was relieved when a secondary appeared in the sternum, and reappeared when the sternal growth was excised.[2] Ewald has shown that, in some cases of thyroid adenocarcinoma which are iodine-free, iodine has been detected in an osseous deposit.[2]

A thyroid osseous metastasis is usually slow in its growth. It had existed for two years in *Case* 1 and for three in *Case* 2. In a case of Halpérine's the metastasis had been present for twenty years—a fact which might well throw some doubt on its malignant nature.[4]

Ehrhardt maintained that thyroid osseous metastases were *never* single, and that multiple deposits were always to be found in cases that came to autopsy. He therefore considered that their surgical treatment was useless.[2] Joll,[4] on the other hand, says that the osseous growth may be the sole metastasis present in the body, and that "this has been confirmed by careful post-mortem examinations". He has not, however, quoted a single case to support this contention, nor have I been able to find any proof of it in the literature at my disposal.

The histology of thyroid metastases is extremely varied and often 'mixed'; so that their structure may be that of a carcinoma, an adenocarcinoma, a 'fœtal adenoma', a simple parenchymatous or colloid goitre, normal thyroid gland tissues, or combinations of any two or more of the foregoing.

DIAGNOSIS.

These growths are specially liable to be mistaken for primary sarcomas; diagnosis, except by the microscope, may be impossible. Radiography can do little more than establish the neoplastic nature of the bony swelling, though of course a periosteal sarcoma might show a definite 'skeleton'. Trotter[5] warns us that "a diagnosis of primary malignant disease of the skull should never be made until the presence of malignant disease elsewhere has been excluded. Examination should be directed especially to the thyroid, kidney, breast, and prostate". One would strongly suspect a thyroid origin in the case of bone growth affecting an elderly woman with some pathological condition of the thyroid gland, particularly if the breasts were normal.

With a metastasis in the skull (the commonest site for such deposits), we would have to eliminate sarcoma (remembering that periosteal sarcoma is the commonest primary tumour of the skull); ivory osteoma; cerebral meningioma involving the skull by direct extension; inflammatory hyperostosis—perhaps syphilitic; dermoid cyst; lipoma; meningocele and the allied conditions; hæmatoma; and subpericranial abscess. Most of these could be rapidly excluded. A deposit in the sternum might closely simulate aortic aneurysm (as in Cramer's case); whilst a vertebral deposit causing angular curvature and paraplegia (as in cases reported by Horsley and Hebbs) might easily be confounded with Pott's disease of the spine.

The nature of both my cases was strongly suspected from the beginning. I unfortunately lacked facilities for establishing the diagnosis of *Case* 1, but in *Case* 2 the metastasis was examined both by radiography and by the microscope.

PROGNOSIS AND TREATMENT.

Bland-Sutton[6] says: " In many instances these secondary tumours have been subjected to operative treatment, and on the whole with satisfactory results", a statement which is borne out by the cases which Joll has recorded —notably Kraske's case in which there was no recurrence after eight years.

A good deal probably depends on whether or not the metastasis is single, and though Ehrhardt maintained that this was never the case, he was probably too pessimistic. Barthels[7] states that "a primary malignant tumour of the thyroid gives a worse prognosis than a metastatic growth", and it certainly appears that the type of thyroid carcinoma which produces bone deposits is unusually 'chronic' and of relatively low virulence.

In the present state of our knowledge it would probably be good practice to remove a single bone metastasis, provided the risk was not excessive, and to follow this up with thyroidectomy. Prophylaxis is, of course, a matter of removing the 'pre-malignant adenoma'. In other words, all tumours of the thyroid should be suspect and their treatment should be that of a potentially malignant growth.

SUMMARY.

1. The discovery, within a short period, of two cases of thyroid bone metastases, affecting natives of the Tanganyika Territory, is a fact of some interest.

2. The general features of thyroid osseous metastases are discussed.

3. The view is taken that all such cases are probably dependent on the presence of a thyroid carcinoma, which, however, may be so atypical, so slow and insidious, that its true nature is apt to be overlooked.

4. It is incredible that a malignant thyroid can produce a benign metastasis.

5. The suggestion that a benign thyroid may produce either a benign or a malignant metastasis is less unreasonable, and is certainly supported by a good deal of incomplete clinical and histological evidence. At present we can only return a verdict of 'not proven'.

6. Where the risk is not excessive and the metastasis is apparently single, the treatment recommended is excision of the metastasis, followed by thyroidectomy.

7. Prophylaxis depends on removing all thyroid tumours as soon as recognized.

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[2] EWING, *Neoplastic Diseases.*
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[5] TROTTER, Choyce's *System of Surgery.*
[6] BLAND-SUTTON, *Tumours, Innocent and Malignant.*
[7] BARTHELS, *Beitr. z. klin. Chir.*, 1928.

THE ANATOMY (COMPARATIVE AND EMBRYOLOGICAL) OF THE SPECIAL THYROID LYMPH SYSTEM, SHOWING ITS RELATION TO THE THYMUS:

WITH SOME PHYSIOLOGICAL AND CLINICAL CONSIDERATIONS THAT FOLLOW THEREFROM.

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THE lymphatic system of the thyroid has attracted the attention of the anatomist from the earliest time. The reason for this is in itself significant. The thyroid is the only gland in which under natural conditions the lymphatic system is found with great frequency to be active and distended with lymph and lymphocytes. The histologist, therefore, had not to await the results of injection and experiment to demonstrate the lymph system in the thyroid gland.

THE INTRA-THYROIDAL LYMPH SYSTEM.

Lymph spaces within the thyroid have been described in particular by Boechat[1] in 1873, Biondi[2] in 1888, Hürthle[3] in 1894, Müller[4] in 1896, Régaud and Petitjean[5] in 1909, and by Matsunaga[6] in 1909. Boechat's[7] description still stands to-day as comprehensive :

". . . on a, en effet (dans le corps thyroïde) un épithélium réposant sur un endothélium, mais il est à remarquer qu'ici l'endothélium sous-épithélial fait partie d'un sinus lymphatique". In our first study of the gland[8] we confirmed Boechat's view. Each follicle of the thyroid lies in a lymph space so arranged that the thyroid epithelium is bathed directly by any lymph contained therein (*Fig.* 324). Groups of such follicles with their perifollicular spaces are enclosed in a fibro elastic capsule lined by endothelium (*Fig.* 324). Within the limit of this lining endothelium the perifollicular spaces are continuous one with another, forming slit-like channels
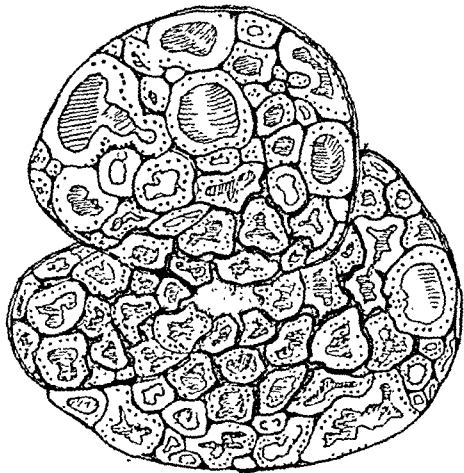
FIG. 324.—Drawing of three encapsuled groups of follicles showing their perifollicular lymph spaces or sinusoids emptying into a common central lymph space—the intra-lobular lymphatic.

running between the individual follicles. These channels are portions of the endothelial-lined sac rendered visible by fluid contents. It is to this endo-thelial sac with all its tortuous interfollicular channels that we have given the name " *lymph sinusoid*." Each lymph sinusoid within which are packed columns of thyroid epithelium and a blood-capillary plexus represents one " *gland-unit*."* Groups of these encapsuled gland-units are regularly clustered about a central lymphatic channel into which their sinusoids open freely (*Fig. 324*). They are bunched around this channel like grapes about a stalk. Each bunch of gland-units forms a lobule of the gland and is enclosed in a special compartment of the interstitia.[9]

This arrangement is an analogous one to that found in the liver lobule.† In the liver, groups of blood sinuses, each contain-ing columns of liver epithelium, a 'Kupffer cell plexus'‡, and blood sinusoids are clustered about a central vein, the hepatic vein; into this vein the portal blood sinus-oids open. The difference in structural arrangement between these organs is that in the thyroid *lymph takes the place of portal blood*. From this it is safe to infer that the lymph is as significant to thyroid function as the portal blood is to liver function.

The Interstitial Lymph Channels.—Let us follow the course of the thyroid lymph from these lobules through the gland. The central intralobular lymph channels which receive their lymph from the sinusoids leave the lobules and unite in the interstitial tissue of the gland. Here again we find a peculiarity about the arrangement of the specific lymph-vessels. They run in the course of the branches of the main artery to the gland, the inferior thyroid artery.[13] From the gland they emerge as a number of discrete trunks on the postero-mesial sur-face of each lobe at the well-marked hilum—that is, at the point of entry of the inferior
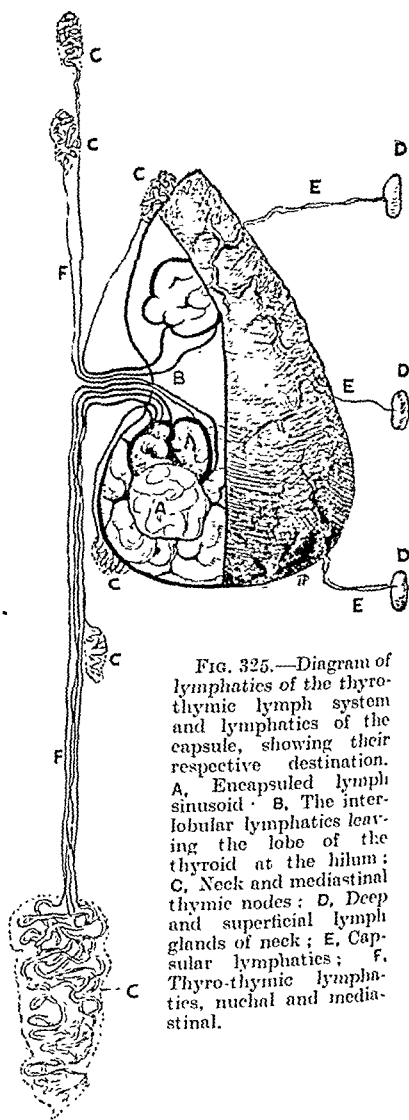
FIG. 325.—Diagram of lymphatics of the thyro-thymic lymph system and lymphatics of the capsule, showing their respective destination. A, Encapsuled lymph sinusoid · B, The inter-lobular lymphatics leav-ing the lobe of the thyroid at the hilum; C, Neck and mediastinal thymic nodes : D, Deep and superficial lymph glands of neck ; E, Cap-sular lymphatics ; F, Thyro-thymic lympha-tics, nuchal and media-stinal.

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* By gland-unit we mean the unit-area of associated tissues (epithelium, blood capillaries, lymph spaces, etc.) necessary for the exercise of the specific function of any gland.[8]

† According to Delépine,[10] Mall,[11] and McNee.[12]

‡ The Kupffer cells of the liver sinusoids are reticulo-endothelial cells and similar in every way to the reticulo-endothelial cells of the thyroid sinusoids. (*See* Williamson and Pearse, *Jour. Pathol. and Bacteriol.*, 1926, xxix, 167.)

thyroid artery. It is noteworthy that the specific thyroid lymphatics, which we are describing here, do not follow the course of the veins as is commonly the case in most other organs. The veins leave the thyroid by the shortest route and emerge in the capsule over the whole surface of the gland. These veins have their 'lymphæ comites' which drain into the nearest lymphatic glands (Poirier[14]), and it is these 'lymphæ comites' of the veins which alone, up to the present, have been familiar to physiologists and surgeons. In the thyroid, however, we are presented with another lymphatic system which runs a specific course of its own within the gland and emerges as a collection of discrete vessels from the hilum of each lobe (*Fig.* 325).

The Destination of the Special Thyroid Lymph-vessels.—The fact that the special thyroid lymph channels are often naturally distended with lymph and occasionally with lymphocytes enabled us to trace them in serial sections to their termination. They can be followed in continuity from the
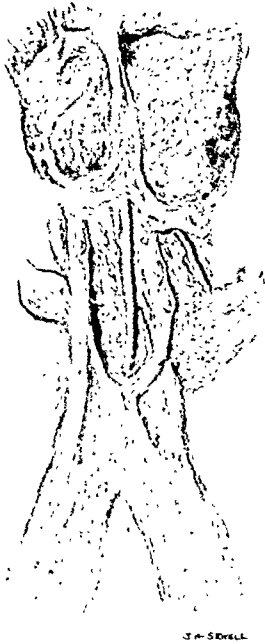
FIG. 326.—Drawing of the anterior aspect of a specimen of a thyroid and thymus taken post mortem, showing the fibrotic cords of lymphatics (Piersol's ligament) uniting the two organs. The leash of lymphatics on the left side is cystic.

FIG. 327.—Cystic distension of the essential endothelial spaces of the thyroid. The material found in these cysts contains neither iodine nor thyroxin: they are therefore distinct from the vesicular colloid cysts. The gland is an adenoid goitre from a case of primary Graves' disease.

thyroid into thymus tissue. As the vessels run down the neck they form the so-called thyro-thymic ligament of Piersol (*Fig.* 326), or they may continue as discrete vessels ending in the mediastinal thymus. As we demonstrated in previous publications,[13, 15] besides ending in the mediastinum these lymph channels also end in nodes of thymus tissue situated in the hilum and beyond the upper pole of each thyroid lobe. The proof that such lymphoid nodes in the neck are thymus depends upon finding Hassall corpuscles in the tissue.

Pathological material also provides a proof of the course taken by these special lymphatics of the thyroid. The material suitable for this purpose can be taken either (1) from cystic conditions of the thyroid found, for example,

FIG. 328.—The intrathyroid lymph spaces. The three drawings illustrate the same lymph space (shown in the centre of A and C; below and to the right of the centre of B) sectioned at different levels. In A a blood capillary is seen within the space, demonstrating that the space cannot be a 'catarrhal' thyroid follicle. The other sections (B and C) show an intense proliferation of the endothelium, which is ultimately desquamated into the lumen as shown in A.
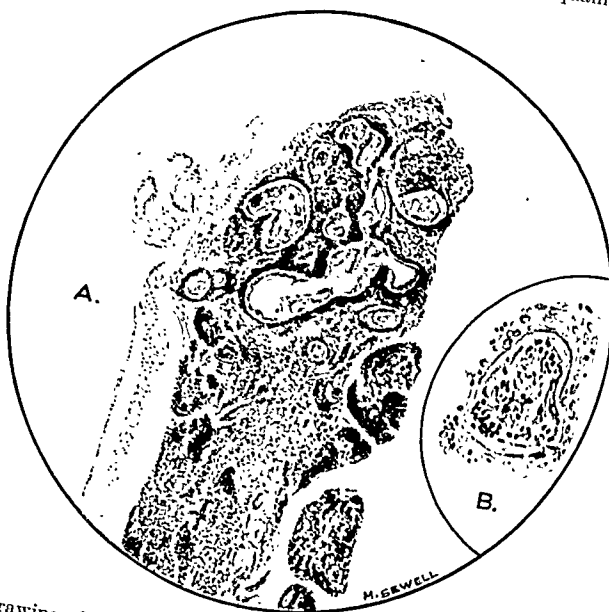
FIG. 329.—A, Drawing of thymus from the same case as *Fig. 328*, showing cystic dilatation of the thymic portion of the thyro-thymic lymph channels; B, Details of proliferated endothelial wall of a dilated thymic channel. The section illustrates the identity of the thymic channels with those of the thyroid, and further shows that the same functional activity engages both parts of the thyro-thymic lymph system simultaneously.

in Graves' disease or lymphadenoid goitre,[16] or (2) from malignant disease of the thyroid.

Primary cysts* of the thyroid are of two kinds : the familiar encysted vesicles distended with colloid, and lymphatic cysts lined with endothelium (*Fig.* 327). It is with the latter only that we are here concerned. Cystic conditions of the lymphatics permit us to trace the course of the trapped
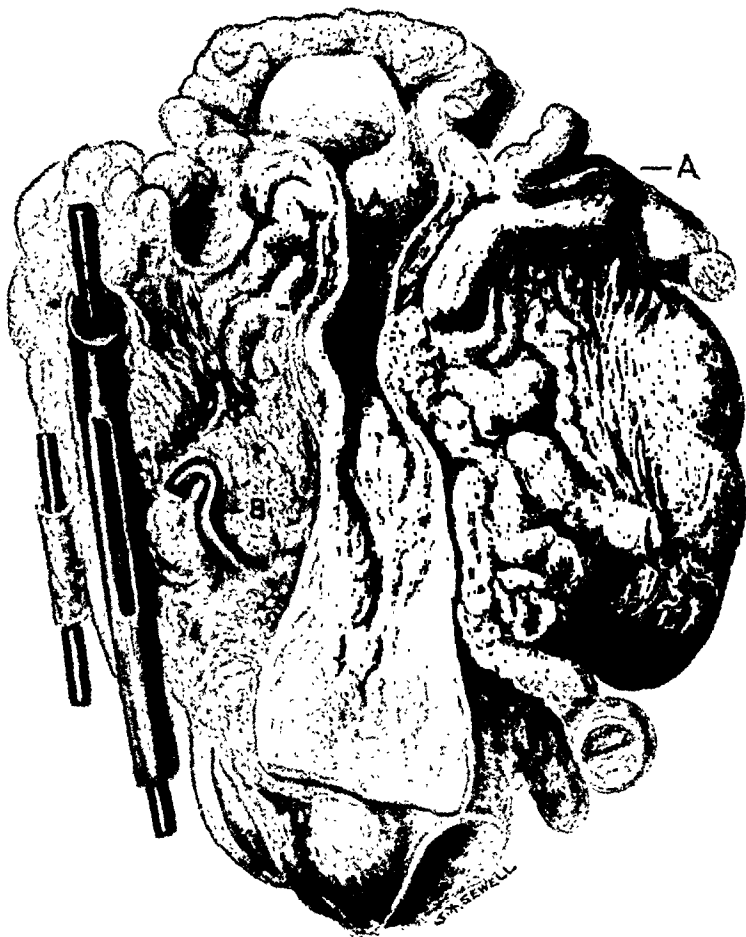
FIG. 330.—Posterior view of a thyroid gland removed post mortem. The right lobe is occupied by a proliferating cancer. The lymphatics emerging from the hilum of each thyroid lobe are distended with cancerous growth. Note that they pass up the neck as well as down towards the mediastinum. A, Lymphatics ; B, Left inferior thyroid artery ; C, Right superior thyroid artery ; both these vessels are patent. (*R.C.S. Museum.*)

lymph. The dilated channels may begin in distended sinusoids, pass to the hilum of the lobe, and thence travel down *and up* the neck. But in every case they end blindly in thymic tissue. Again, that these nodes in which they terminate are thymus is determined by the presence of Hassall corpuscles.

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* Secondary cysts are those due to hæmorrhage or to colliquative necrosis.

Distended channels of this order are encountered in the fœtus, in childhood, in Graves' disease, and in old age (*see Fig.* 326).

The most striking example of dilatation of the thyro-thymic lymph channels occurs in lymphadenoid goitre,[16] both in the natural disease and in the experimental conditions in rats.[17] Here, moreover, the whole of the special lymph tract is not only dilated but also in a state of pronounced functional activity. In this condition the special lymph channels are filled with proliferated *endothelial cells* as well as lymph and lymphocytes, so that 'they can be traced as very striking structures from the thyroid lymph sinusoids (*Fig.* 328) to their blind termination in thymus tissue anywhere in the neck or mediastinum (*Fig.* 329). *Figs.* 328 and 329 are serial sections of thyroid and thymus to show the distended lymph spaces filled with lymph and proliferating endothelium. The sections are from a rat in which lymphadenoid goitre has been experimentally produced by Colonel McCarrison.[17]
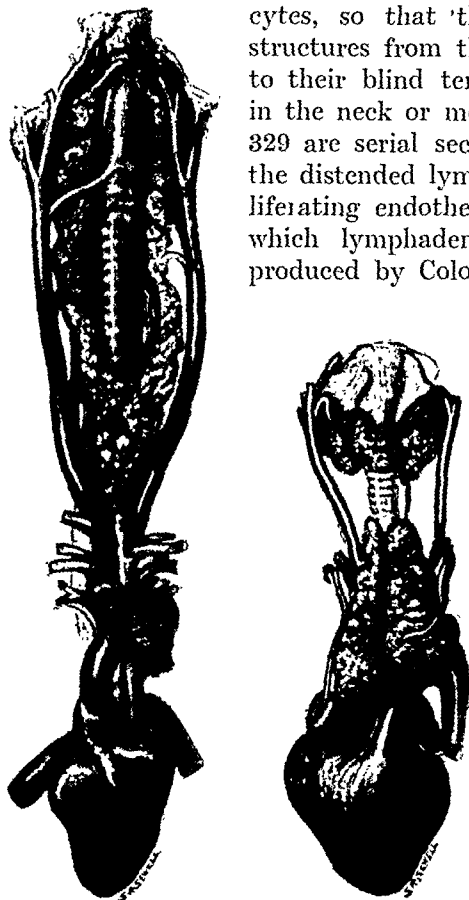
FIGS. 331, 332.—Drawing of specimens attributed to Sir Astley Cooper, who injected the thyroid gland in a successful attempt to infiltrate the thymus and its ' absorbent vessels ' with mercury. *Fig.* 331, Probably in young calf. *Fig.* 332, Human infant. (*R.C.S. Museum.*)

Malignant disease of the thyroid often presents a beautiful natural injection of this special lymph system. The growth can at times be followed in continuity from its origin in thyroid epithelium within a lymph sinusoid, along the interstitial lymph channels to the hilum of the lobe, and thence *up as well as down* the neck into thymus tissue (*Fig.* 330). Again the criterion which determines that the lymphoid tissue is thymus is the presence of the Hassall corpuscles (Tebbutt and Woodhill[18]).

Thus we see that both natural injection and pathological distension of the thyroid lymph spaces allow us to trace a special lymphatic system common to the thyroid and thymus. We learn from these specimens that thymic tissue is distributed over an area extending from the base of the skull to the pericardium—that, in fact, the thymus is a neck as well as a mediastinal organ. As far as we can see there seems to be no connection between this thyro-thymic lymph system and the cervical lymph glands. *The thyro-thymic lymph system seems to be a closed system.*

Now in a previous paper[13] we recalled the fact that the discovery of the thyro-thymic lymphatic channels was due to Sir Astley Cooper,[19] who described

them in 1832. He injected the thyroid lymph spaces from the thymus. We have failed to find any valves in these lymph channels—so that no conclusions may be drawn from his procedure as to the natural direction of flow in this system. In the living, however, the spread of some forms of cancer seems to indicate that the open course of flow is from the thyroid to the thymus tissue. Recently Sir Arthur Keith has found in the Royal College of Surgeons injection specimens of thyroid and thymus attributed to Sir Astley Cooper (*Figs.* 331, 332). These specimens show that experimental injection of the thyro-thymic lymph channels fully confirms the conclusions drawn from the other and more natural sources.

We must conclude therefore that in mammals the thyroid and thymus are directly connected through a common lymphatic system. What, then, we must ask, is the essential structure and nature of the thymus ?

STRUCTURE OF THE THYMUS.

The thymus is composed of lymph tissue*, though it has not the nature of a lymph gland. According to the current description given, it is a mediastinal organ composed of lobules set in series along a coiled fibrous strand (*Fig.* 333). If, however, we go back to the work of earlier investigators, we find that they held somewhat different views. In 1845 Simon[20] published his results of a detailed study of the anatomy and comparative anatomy of the organ. He demonstrated that in birds and mammals the thymus was a neck organ. He knew it to be distributed in a particular fascial plane immediately ventral to the great vessels of the neck and extending from the base of the skull to the pericardium. In mammals the bulk of the organ lay anywhere in the region *above or below, or intermixed with the thyroid gland.*

Simon, moreover, held that the bulk of the gland was composed of a series of fine much-plicated tubes. He showed that the wall of each tube was composed of endothelium. In the wall, or in the saccules off the wall, occurred lymphocytic aggregations or lymph nodes (*Fig.* 334). Now Simon knew that the lymphocytes were *dynamic* and not static features; they come
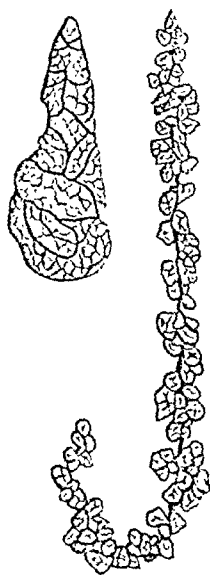
Fig. 333.—Diagram to show the construction of the thymus. The lobules are described as clustered about a connecting fibrous cord. We have since shown that the fibrous cord is made up of a leash of lymphatic channels. (*After Sappey —Quain's 'Anatomy.'*)
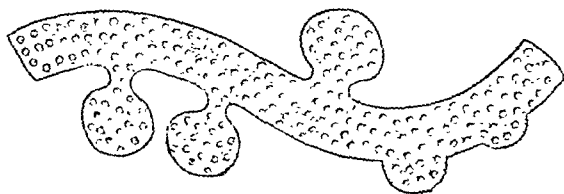
Fig. 334.—Diagram to show the formation of the plicated thymic tube in the wall of which are set the thymic follicles. (*Simon.*)

* Leaving aside the Hassall corpuscles, with which we are not at present concerned.

and go under functional stress. This transient nature also belongs to the fat which may replace the lymphocytes, as he showed in his study of hibernating animals. In this connection we must stress the fact that it is these functional and dynamic features, i.e., lymphocytes and fat,* rather than the anatomical structure of the thymus, which do not persist in the mediastinum with age. The lymph channels, which are the essential structural feature of the thymus, persist throughout life. The thymus as a tubular lymphatic organ remains. With age its function alone changes, and this only quantitatively, for it can be shown that if the nodes of thymus in the human neck are examined, even the lymphocytic function persists to some degree throughout life in most bodies. If, therefore, we are to understand the nature of the thymus we must cease to look for aggregates of lymphocytes as a proof of its existence, for these are but a functional feature of its endothelium.

The body of the thymus gland, then, is made up of an aggregation of much-plicated endothelial lymph tubes in the walls of which lymph nodes may or may not be present. The lymph tubes are themselves the blind terminals of the special thyroid lymphatics. Thus the thymus is essentially a *lymph reservoir*; and we can but conjecture that this reservoir is for the storage of some product of thyroid activity. *The thyroid and thymus are thus not two organs, but different parts of the same organ.* This is a very important conclusion for anatomy, but we have still to determine whether the association of these structures is an acquired peculiarity of mammals or a fundamental arrangement found in all vertebrates. If it is as fundamental as it appears, then it will be fully represented in both the embryology and comparative anatomy of the two organs. If the association is a special feature acquired late in the evolutionary process, then again it is important to determine the particular point at which it was acquired. It is along such lines of inquiry that we may hope to find a clue to the function of the two organs.

EMBRYOLOGY AND COMPARATIVE ANATOMY.

The thyro-thymic lymph system as a whole is divided naturally into two parts, that which lies within the thyroid and that portion which lies beyond the gland. We propose henceforth to speak of these two as the *intra-thyroidal* portion and the *extra-thyroidal* portion of the thyro-thymic lymph system.

EMBRYOLOGY.

In the embryo the thyroid first appears as a groove or dimpling at the site of the foramen cæcum in the floor of the buccopharynx. Even before the groove appears the site of origin can be identified readily by an accumulation of chromophil substance in the epiblast. The primary epiblastic groove deepens and a bud appears growing down into the underlying mesoblast. The bud itself is composed of both epiblast and mesoblast. The head of the growing bud increases in size as it moves tailwards through the mesoblast, so that it soon appears as a pear-like mass attached by a long stalk to the

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* We ought to add endothelial proliferation as an additional functional factor appearing at times in the thymus. The large endothelial cells fill with lipoidal matter.

region of the foramen cæcum. The mass or body of the gland at this stage is closely invested by the surrounding fibroblastic tissue (*Fig.* 335*a*).

FIG. 335.—Diagrammatic representation of stages in the early development of the thyroid lymph system. *a*, Thyroid bud growing from a groove in the floor of the pharynx (P), formed of both 'epiblast' and 'mesoblast' and at first a compact mass; *b*, The appearance of spaces in the bud breaking up the epithelium into partially discrete masses; *c*, Fusion of these spaces at the periphery of the bud resulting in the formation of one large cavernous space enclosing the whole gland.
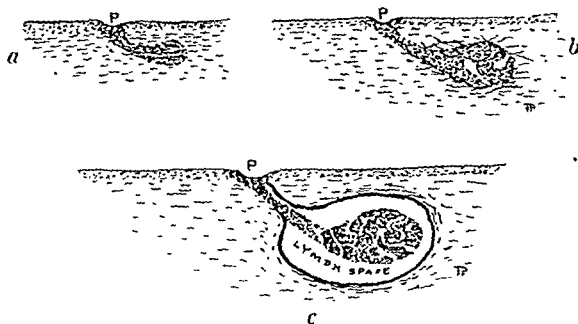
Next there appears within the pear-shaped body of the gland a series of spaces* which break up the mass into a collection of units (*Fig.* 335*b*). These spaces we interpret as the precursors of the intra-thyroidal lymph system, and we believe that they will be found to arise from the contained mesoblastic element in the thyroid bud. As development proceeds, the spaces extend to the periphery of the mass. Here they fuse, forming a continuous space separating the primitive gland from the surrounding fibroblastic tissue. The newly formed anatomical feature is thus a large cavernous space in which the thyroid is suspended (*Fig.* 335*c*).

Thus the human thyroid gland at the 60-mm. stage of the embryo can be described as a stalked organ floating in a large lymph space. The stalk is the thyroglossal duct. The space surrounding the gland extends up to the floor of the mouth. The blood-vessels to the gland cross the space from the side. The figure showing this stage (*Fig.* 336) is taken from Bérard

FIG. 336.—Photograph of a section of a human embryo showing the thyroid lying within an extensive lymph space (outlined in white). (*After Bérard and Dunet.*)

* Norris,[21] who first described this early development of the thyroid, carefully points out that the spaces which form at this early date are not thyroid follicles. The follicles appear at a later stage of development.

and Dunet.[22]   It must be carefully noted that the region in the embryo in which this development occurs extends from the hyoid arch through the whole gill-arch area.   The gill arches originally abut on the lateral surfaces of the lymph space in which the thyroid is suspended.   Embryology clearly indicates the importance of the thyroid lymph space, and emphasizes the fact that there develop simultaneously an intra-thyroidal and an extra-thyroidal portion.

The next question we must ask is whether the progress of evolutionary development also bears out the foregoing facts.

COMPARATIVE ANATOMY.

The thyroid system of the full-grown dogfish consists of a large cavernous sac in which floats a pear-shaped thyroid gland attached by a stalk of epithelium to the floor of the buccopharynx at the foramen cæcum (*Fig.* 337).
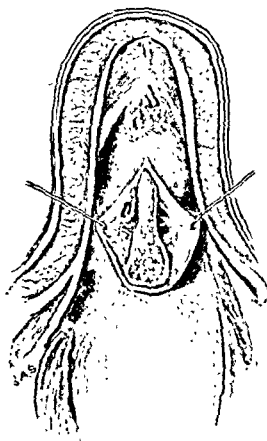
FIG. 337.—Drawing of a dissection of the thyroid of the adult dogfish showing the gland floating in a cavernous lymph sinus.
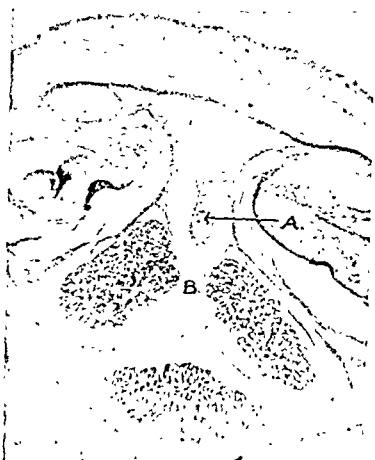
FIG. 338.—Cross-section of the buccopharyngeal region of a young free-swimming dogfish (2·8 cm.) showing the thyroid gland (A) floating within the extra-thyroidal cavernous lymph space (B).   Compare this section with the human fœtal gland shown by Bérard and Dunet (*Fig.* 336).

The gland floating in the lymph is anchored by its stalk and by the two lateral thyroid arteries which cross the cavity from each side.   The thyroid system of the mature dogfish is thus identical with the thyroid system of the 60-mm. human embryo in its general arrangement.   Nor, indeed, do the details differ.   The body of the dogfish thyroid is composed of columns of follicles separated by spaces—the *intra-thyroidal* lymph system—which communicate directly with the large extra-thyroidal cavernous lymph system (*Figs.* 338, 339, 340).   The intra-thyroidal spaces can be filled with injection mass which thereupon passes directly into the cavernous space.   Agreement between phylogeny and ontogeny is thus complete in so far as the essential relation of the thyroid epithelium to the lymph spaces is concerned.   A special thyroid lymph system is apparently a fundamental feature of vertebrates.

But comparative anatomy carries the matter still further, because it indicates the relation of the thyroid to other structures. There are two very special features of the extra-thyroidal lymph-sac of the dogfish to be noted. The first is that the caudal part of the thyroid lymph-sac is attached to the pericardium by a fibrous cord. The proximal portion of the cord is hollow. It represents a caudal extension of the cavity of the thyroid lymph-sac towards the heart; the significance of this we shall see later. The second important point to note is the source of the tributaries to this thyroid lymph-sac. The lymph-sac drains the floor of the bucco-pharynx through many small tributaries. But the *two main tributaries come from the gills* on either side. These tributaries are essentially lymphatic, though it is usual to find in them a few
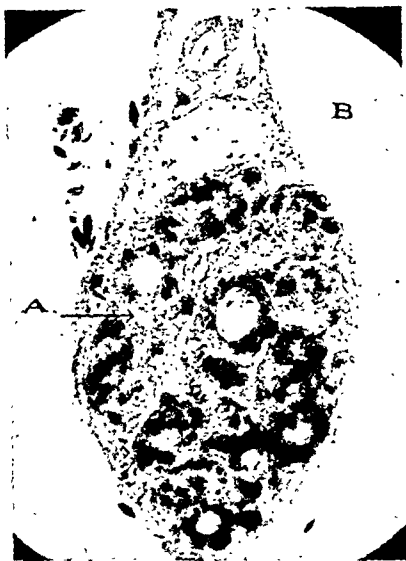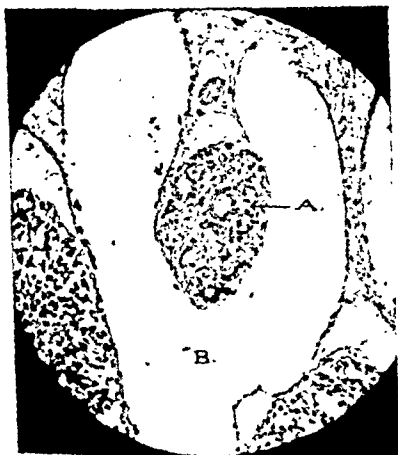
Figs. 339 and 340.—High-power microphotographs of *Fig.* 338, showing A, the peri-follicular intra-thyroidal lymph spaces of the compact thyroid body, which is suspended within a large extra-thyroidal lymph-sac, B.

red blood-corpuscles, because, even at this stage in evolution, there is still a fairly free communication between veins and lymphatics, as Burne[23] has demonstrated. In the dogfish the lymph channels are but a recent evolution from the veins.

Thus the thyroid lymph-sac in the dogfish is formed of a central cavity and two main extensions of the sac draining the gills. We could thus describe the whole thyroid lymph space as a *thyroid-gill lymph system* receiving the subsidiary tributaries from the floor of the mouth. There must be some functional importance to be attached to this arrangement.

For further light on the problem we must turn to a still more primitive thyroid system, namely that of the angler fish (*Lophius piscatorius*).[23] In this fish the thyroid system is even less organized. It consists of a central cavernous lymph-sac to the inner wall of which are attached columns of naked thyroid epithelium.* Into this sac open two main tributaries from the gills as in the dogfish (*Figs.* 341. 342).

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* See BRITISH JOURNAL OF SURGERY, 1926, xiii, No. 51, p. 469, *Figs.* 287–289.

FIG. 341.—Photograph of a dissection of thyroid of *Lophius piscatorius* showing the thyroid lymph-sac with its tributaries from the gills and connections with the heart vessels. The ventral surface of this sac has been removed to show the reticulations of the inner wall which bear the thyroid follicles. (*After Burne.*)
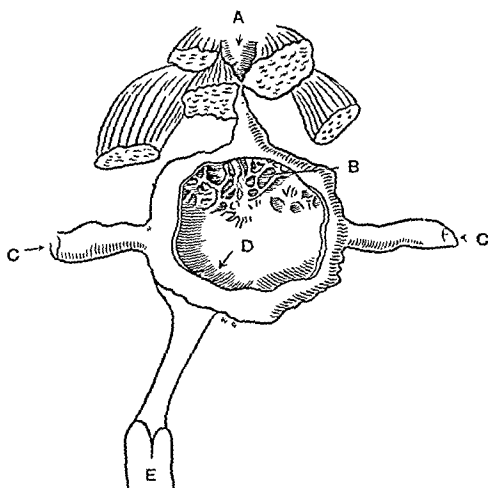
FIG. 342.—The connection of the thyroid and its lymph-sac with the gills and heart. A, Floor of mouth; B, Reticulations bearing thyroid follicles; C, From gills; D, To heart; E, Inferior jugular vein. (*After Burne.*)

Origin of the Intra-thyroidal Lymph Spaces.—In the angler fish the thyroid epithelium is not gathered together to form a compact gland. Solitary columns of follicles are scattered over the inner surface of the central sac. The epithelial columns float freely in the lymph-sac anchored to its wall by their vascular supply—in other words, the intra-thyroidal and the extra-thyroidal lymph systems are here one and the same. The columns of thyroid follicles have not yet been aggregated or bunched together to form a compact mass, thereby separating off a system of perifollicular spaces from the large extra-thyroidal lymph space, as in the dogfish and man (*Fig.* 343 A, B). The

origin of the intra-thyroidal lymph system as seen in dogfish and man has been traced. The arrangement in man is but a modification of the simple cavernous type of thyroid lymph system found in the most primitive specimen. The most important fact is that wherever found the *thyroid epithelium is bathed directly by lymph.*
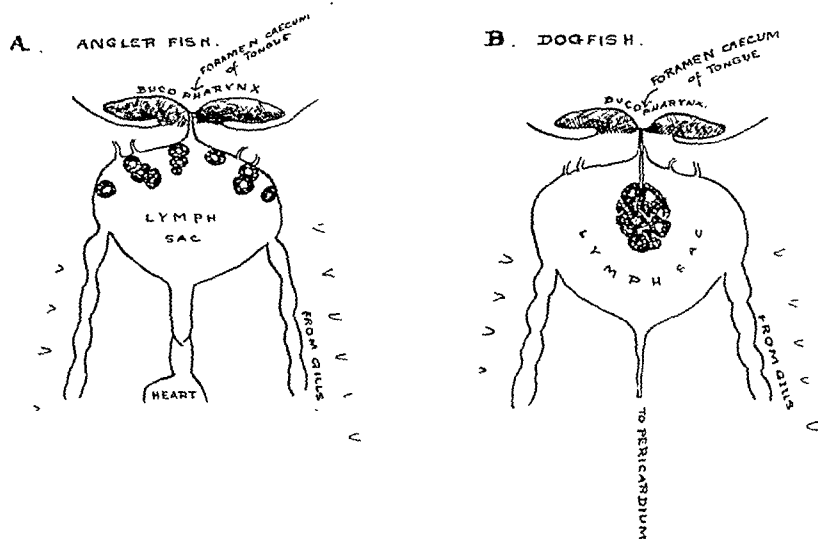
Fɪɢ. 343.—Diagram to illustrate the essential relationships of thyroid epithelium to the lymph and the principal area drained by the special thyroid lymph system. The central space of the lymph system is occupied by *naked* thyroid epithelium, in the angler fish (A) attached to the wall of the sac, in the dogfish (B) clustered about a central stalk. The main tributaries draining into the lymph space are from the gills on either side. Subsidiary tributaries flow into the space from the mucous membrane of the buccopharyngeal cavity. In the dogfish the lymph space appears to be a cul-de-sac, whereas in the angler fish the lymph space opens freely into the heart through the inferior jugular vein. A relic of this channel is represented in the dogfish by the partially hollow fibrous cord attaching the sac to the pericardium.

The Origin of the Thyroid Lymph System as a Whole.—There is yet another feature of this more primitive thyroid-gill lymph system which must be stressed. We have seen that in the dogfish the central thyroid lymph-sac is attached to the pericardium by a partially hollow fibrous cord (*Fig.* 343 B). In the more primitive angler fish this caudal extension of the central sac is joined to the inferior jugular vein and so is in direct communication with the heart cavity (*Fig.* 343 A). This vessel is valved so that the flow of the thyroid-gill lymph is towards the heart (*Fig.* 342). The two main tributaries from the gills are thus brought into direct connection with the heart. Originally they must have been two large lateral sinuses subtending the gills. They occupy, in fact, the position of the ventral venous sinuses found in the larval forms of fish. e.g., ammocoetes. We may therefore conclude that the thyroid-gill lymph space was originally part of the venous blood system.

Relation of the Thyroid-gill Lymph System to the Thyro-thymic Lymphatics. —Now, the thyroid-gill lymph system in fish is bilobed. It lies immediately ventral to the great vessels and the buccopharynx. It extends through the hyoid region over the whole gill-bearing area. Centrally it runs from the base of the tongue to the heart. The position of this thyroid-gill lymph

system in fish is, in fact, that occupied by the thyroid lymph-sac in the human embryo. But in fish in which a cavernous lymph-sac is present no thymus has been conclusively identified.* This is to be expected, for there are not as yet any lymph glands and the purification of the lymph does not excite lymphocytosis in fish. In birds and mammals we have already seen that the thymus is a lymph organ occupied by the plicated lymphatic vessels of the extra-thyroidal lymph system. We have, moreover, seen that the thyroid apparatus in man, including the thyro-thymic lymphatics and the thymus, lies in a specific fascial plane. and that the thyroid lymph-sac in fish occupies precisely the same fascial plane. The anatomical relations of the two are identical. For the thymus, therefore, to become part representative in man of the thyroid-gill lymph-sac of fish, there only is left to explain the translation of a saccular cavernous space into a series of tubular capillary spaces. This is precisely what does happen in the evolution of all vascular channels, whether arterial, venous, or lymphatic. They begin primitively as irregular cavernous spaces, and, under the pressure of the conformation of surrounding structures and because of the need of a more specific directional flow of the contained fluids, are transformed into tubular structures. We may infer, therefore, from comparative anatomy and embryology that the thyro-thymic lymph system of mammals is derived from a thyroid-gill lymph system found in fish.†

The thyro-thymic lymph system is a fundamental part of the thyroid apparatus which is preserved with modifications throughout the vertebrate kingdom. It has its origin in the vascular system of the gills of the primitive vertebrate.

The thyroid lymph system must play an important part in the physiology of the thyroid apparatus. In fish the thyroid hangs suspended in a lymph vascular system emptying into the heart. We must draw attention to the analogy between the thyroid epithelium bathed by the returning lymph from the gills en route to the heart, and the liver epithelium bathed by the returning blood from the intestine en route to the heart. We began with an analogy between the thyroid and liver and end with an even more significant analogy between the same two organs. The gill membranes and the buccopharyngeal membranes, from which the thyroid lymph is derived in fish, are in direct contact with the watery environment, and so with any substance, oxygen, salts, etc., dissolved therein. The thyroid epithelium is in a position to act on the lymph from the gills in the same way as the liver epithelium acts on absorbed material from the gut. In man the gills have disappeared, but the original gill-lymph space remains as the thyro-thymic lymph system to fulfil some function which was once included in the general respiratory function in fish. Perhaps herein lies a clue to the function of the thyroid apparatus as a whole in man.

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* The organ of Stannius in fish has frequently been considered as the representative of the thymus. Its structure, however, is that of a tonsil; it is not related serially to the gills or gill clefts; it has no relation to the great vessels; it does not lie in the ventral fascial plane, and is far removed from the thyroid.

† We are not concerned at this point with the evolution of the Hassall corpuscles and other formed structures in the human thymus, but with the plicated lymphatic spaces which form the main bulk of the organ.

CONCLUSIONS.

The foregoing facts make it clear that not only are the thyroid and thymus an integral part of one apparatus, but that the thyro-thymic lymph system is pivotal in the functioning of both organs. What light does this throw on the physiology of the thyroid ?

Now the histologist has always insisted that the elimination of some thyroid secretion takes place via the lymphatic pathways of the gland. The physiologist, however, up to the present has found no proof of this by experiment because he has been content to accept iodine, and iodo-colloid alone as evidence of thyroid activity. The histologist agrees with the physiologist *that the passage of 'iodo-colloid' and iodine through the gland never implicates the lymphatics.* We ourselves have studied colloid both entering and leaving the follicles, but under neither circumstance have we ever found it cause any change in the appearance of the lymph sinusoids in the thyroid or of the lymphatic channels of the thymus.[8*] Nor does the thymus contain iodine or thyroxin. Recent studies of the iodine values of the blood entering and leaving the thyroid respectively lend support to the contention that iodo-colloid leaves the gland through the blood-stream.[24, 25] Furthermore, Carlson and Woelfel,[26] and more recently Hicks,[27] have shown that iodo-colloid does not leave the thyroid along the lymphatics of the capsule. Nor does it enter the lymph glands of the neck. In fact all the available evidence, both positive and negative, indicates that colloid is eliminated by way of the blood channels. Nevertheless the histologist still insists that *some product* of thyroid activity is eliminated by the lymph pathway—for example, Bondi,[2] Hürthle,[3] Langendorff,[28] and Launoy.[29]

What, then, we must ask, is the product of cellular activity of the thyroid —clearly a secretion†—which histologists constantly have observed inciting a reaction in the lymphatic channels ?

We have shown that this secretion is the misnamed 'secretion of hyperplasia' with which the physiologist, pathologist, and surgeon alike are so familiar. This secretion is not only histologically different from iodo-colloid.[8] but neither is its chemical nor is its biological action that of iodo-colloid.[30] The two secretions are in fact distinct entities ; they are neither similar nor derivative.[31] This other secretion can be seen traversing the epithelium from the lumen of the follicle to enter the perifollicular lymph spaces, and, as we have already seen, can be followed from thence into the thymus.[13] On reaching thymic tissue it stimulates the endothelium of the lymph spaces to

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* In a recent publication on the subject (Orr and Leitch, "Iodine in Nutrition", M.R.C. *Reports*, 123, 1929) we are erroneously quoted as holding precisely the reverse opinion.

† We use the term 'secretion' in this paper in the generally accepted sense meaning any material accumulating within the thyroid follicle. In this sense colloid is a secretion. In our earlier histological studies we restricted the term 'secretion' to the substance which accumulates in the follicles as a result of an activity of the thyroid epithelium identical with that described as the 'secretory' process in other glands such as the pancreas or submaxillary—namely, accumulation of granules, liquefaction of the protoplasm, vacuolation, etc. In this latter sense colloid is not a secretion. It accumulates within the follicle without any visible change in the physical condition of the epithelial protoplasm or the nuclei.

produce lymphocytes. Under certain normal conditions this secretion may even stimulate the endothelium of the thyroid lymph sinusoids or the interstitial lymph channels of the thyroid to emulate thymus, producing thereby a characteristic aggregation of lymphocytes in the thyroid. In other words, *this secretion can stimulate the production of lymphocytes throughout the thyro-thymic lymph tract.* The secretion is, in fact, a lymphogenic substance, which iodo-colloid (thyroxin) is not. For these and other reasons we must in future speak of this secretion in contradistinction to the iodo-colloid as the *lymphogenic secretion* of the thyroid. The two thyroid secretions can no longer be confused : they are iodo-colloid secretion and lymphogenic secretion.

The surgeon is very familiar with the lymphogenic secretion—for, as we have said above, it is the secretion of 'hyperplasia' found in goitre. The term 'secretion of hyperplasia' is unfortunate, for this 'hyperplasia', as Marine and most other workers have shown, is a *normal* procedure. The Continental workers* have always avoided this confusion, for they speak of the so-called pure hyperplastic goitre as 'struma parenchymatosa'. Further, when both lymphogenic function and colloid function are involved they speak of 'struma parenchymatosa et colloides', and when lymphogenic function is entirely in abeyance they speak of 'struma colloides'. They have three clear pictures of the possible combinations of these two functions in goitre. Struma parenchymatosa diffusa is the adenoid goitre,† not, as used to be taught in England, the colloid goitre. If in future we speak of 'lymphogenic hypertrophy',‡ 'lymphogenic + colloid (or mixed) hypertrophy', and 'colloid hypertrophy' severally, we shall avoid much confusion in discussing goitre. It might be asked why we should not adopt the Continental terminology. The reason is obvious ; both secretions are indeed 'parenchymatous' in the proper sense of the word, for they are both held within the parenchyma of the gland.

We have shown elsewhere[31] that lymphogenic secretion is responsible for the toxic state in Graves' disease and toxic goitre—in fact, for all forms of thyrotoxicosis. Lymphogenic secretion is Plummer's 'poor substance', to which he has assigned a definite group of toxic symptoms in Graves' disease.[33] Now in our experience every case of thyrotoxicosis coming to post-mortem examination is suffering from status thymico-lymphaticus.§ This is also the general experience on the Continent and in America. Indeed, Graves' disease has been called toxic status thymico-lymphaticus.[29, 34] The facts set forth in this study give a reason for the association of these conditions. Status lymphaticus is an essential part of the *overaction* of the lymphogenic function of the

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* *See*, for example, de Quervain[32] and *Report of International Conference on Goitre, Berne,* 1927.

† A gland in which the whole tissue is occupied in producing lymphogenic secretion to the exclusion of iodo-colloid storage. (*See* Williamson and Pearse.[16])

‡ By hyper*trophy* we imply an increase in the functional activity of an organ. If this hypertrophy is maintained by the growth of new cells to meet the demand, then a hyper*plasia* will appear.

§ Since Graves' disease and toxic goitre occur in adults the status thymico-lymphaticus cannot be confused with the problematic conditions thus described in this country as the cause of sudden death in children.

thyroid. The excess of lymphogenic secretion is stored in the thymus. We may consider this physiological procedure as indicating that the lymphogenic secretion after it leaves the follicles is in itself (and normally) toxic, and that it has to be detoxicated by the endothelium giving rise thereby to local lymphocytosis.* When the surgeon by amputation removes the excess of lymphogenic secretion in the thyroid, he relieves the toxicosis : indeed, that is the only conclusive test for thyrotoxicosis. Furthermore, some surgeons[35-37] have treated cases with success by operating on the thymus.† The explanation of the success of either of these procedures arises out of the facts set forth in this paper. Obviously it is a more certain procedure to attack the seat of manufacture of the lymphogenic secretion in the thyroid rather than its thymic storehouse. Thymectomy can never be looked upon as the better procedure.

Our studies also explain another fact. Bircher has succeeded in producing Graves' disease experimentally in dogs. He implanted into the peritoneum thymus tissue from cases of Graves' disease, and status thymico-lymphaticus and Graves' disease—the full syndrome (exophthalmos, goitre, and tachycardia)—resulted from his procedure.[38] Now the normal lymphoid thymus represents *only the detoxicated secretion* ; its administration, therefore, does not cause Graves' disease experimentally. Nor, we have found, does the lymphogenic secretion *while it is in the follicles* of the thyroid produce Graves' disease when given to animals. The lymphogenic secretion must, in fact, be caught in transit *from* the thyroid to the thymus if it is to be used successfully in producing experimental Graves' disease. Hence success followed Bircher's use of the *semi-cystic* thymus from Graves' disease and status thymico-lymphaticus. *We are forced to the conclusion that thyrotoxicosis would seem to be due to a failure of the lymphatic endothelium of thymus and thyroid to effect the natural detoxication of the lymphogenic secretion produced by the thyroid.*

While dealing with the subject of status lymphaticus as an essential part of thyrotoxicosis we would make a suggestion. It is probable that the degree of status thymico-lymphaticus present in any patient is an index of the risk of death during operative procedures ; we refer especially to sudden death. This matter is still one of importance, for the risk at operation has not disappeared with the use of iodine prophylaxis. The thymus cannot be inspected clinically nor can its degree of enlargement be satisfactorily determined ; it is, then, desirable to find some means of gauging the severity of the condition in the patient.

Now the studies presented in this paper show that the thyro-thymic lymph space surrounds the thyroglossal duct. It is not surprising therefore to find that accompanying thymic enlargement in thyrotoxicosis there is a corresponding enlargement of the lymphatic tissue in the posterior third of the tongue —the 'thyroid trigone' of the tongue as it might well be called. Now this area can be inspected, and it may thus afford the clinician a convenient means of estimating the degree of status thymico-lymphaticus present in any case

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* A similar procedure happens in lymph glands behind a septic focus.
† Halsted has collected 500 cases of thymectomy for Graves' disease.[36]

of thyrotoxicosis or Graves' disease (*Fig.* 344).   Further, the thymic lymph space may still retain some of its connections with the buccopharyngeal lymphatics apparent in fish ; so that, to rid the patient of enlarged tonsils and remove septic foci from this region would seem to be a necessary procedure, as experience has demonstrated.

FIG. 344.—Photograph of the ' thyroid trigone ' of the tongue in a case of Graves' disease, showing the hypertrophy of the lymphatic tissue of this area which accompanies the status thymico-lymphaticus present in this disease.

We may now look at another aspect of Graves' disease on which these researches may have some bearing — namely, tachycardia, which is a cardinal symptom of the disease.   We have seen that the thyroid lymph system is part of the main *gill-vascular circuit* in some fish, and that it opens directly into the heart.   This direct connection is lost in man, but clinical experience proves that the association between the thyroid and the heart is far from being lost.   Without going into details in this paper it can be said that in the primitive fish and its vertebrate ancestor the thyroid and vascular system are also associated through a *special nerve-arc* of very peculiar nature which links the thyroid epithelium to the muscles of the gill-venous lymph system.[39]   There is reason to suppose that this thyroid-vascular nerve-arc is also present in man, but we must reserve consideration of this fact for a later paper.

There are other lymphatic conditions of surgical interest which may possibly be explained by our studies of the thyro-thymic lymph system.   We refer to the cystic hygromas.[40-44]   The probability is considerable that the cystic hygromas are due to developmental abnormalities of the thyro-thymic lymph tract.   These swellings are known to be endothelial-lined cysts, and are peculiar in that their walls are constantly found to contain both fat and lymphocytes.   In this respect their form and function recall forcibly the description given by Simon of the nature of the thymic lymph spaces in animals.[20]   Furthermore, in the human embryo at a certain stage in development the thyro-thymic lymph system is a large cystic cavity pervading the structures of the neck.   The sites from which these tumours grow, where they have been discerned, as in small tumours or early stages of cystic distension, coincide closely with the position of the thyro-thymic lymph tract.   The fact that they should become grossly cystic and invade more distant parts, such as the shoulder muscles, is to be expected, therefore, if they develop within a closed thyro-thymic lymph system.

There is a further point which is noteworthy in this connection.   We refer to the fact that, according to the recorded history of many cases of cystic hygromas, the swellings tend to manifest themselves, or on the other hand to enlarge, shortly after birth, and again at or about puberty.   Now these are periods of enhanced lymphogenic activity of the thyroid gland, and as we

have seen above it is the lymphogenic activity of the thyroid which induces a lymph flow in the thyro-thymic tract. Increase in the size of the hygromas at these periods would therefore be what we should expect were they thyro-thymic lymphatic formations. Clearly the lymphatic hygromas need reviewing in the light of this new knowledge.

Lastly, we must return to the subject of the thyroid lymphatics in their relation to thyroid cancer. The fact that there are two distinct systems of lymphatics emerging from the thyroid gland—(1) the 'lymphæ comites' of the veins, i.e., lymphatics of the capsule, and (2) the thyro-thymic lymph system (*see Fig.* 325)—leads us to scrutinize closely the thyroid neoplasms. Theory suggests the division of these neoplasms into : (1) Those which primarily invade the deep cervical glands of the neck and in this way resemble the cancers of adjacent organs, e.g., œsophageal cancer ; and (2) Those which primarily invade the thymus. In clinical experience this theory is not without support. Every surgeon dealing with the thyroid knows that some thyroid cancers, true to type, invade the lymph glands—the deep cervical group. But the other thyroid neoplasms, which are of the greater number, are atypical in their history, sequence, and spread. Again, the frequency with which certain thyroid growths invade the mediastinum without involving the adjacent deep cervical glands at all is very well recognized.[45, 46] In view, however, of the anatomy of the specific thyro-thymic lymph tract which we demonstrate in this paper, this seeming peculiarity of the direction of the spread of thyroid cancer is precisely what we should expect to find. Any proliferating growth of the thyroid epithelium may fill the lymph sinusoids and extend naturally along the thyro-thymic lymphatic channels into the thymic lymph reservoir. Furthermore, the extensive distribution of some cancers into positions anywhere in the neck from the base of the skull to the mediastinum is also explained, for we must expect invasion of thymus tissue wherever it lies, and as we have shown, the thymus is a neck organ as well as a mediastinal one. (*See also* Tebbutt and Woodhill.[18])

Now if the thyroid and thymus are functionally but one apparatus as phylogeny and ontogeny insistently indicate, any growth confined within the specific thyro-thymic lymph system is still a *growth confined within the organ of its origin*. In this sense such a growth cannot rightfully be classified from the pathologist's point of view as a true malignant neoplasm ; it must rather be called a hyperplasia. Possibly the anomalous names used to describe certain of the thyroid tumours foreshadow this fact. We refer, for example, to designations such as 'aberrant thyroid tumour', 'metastasizing adenoma', 'benign metastatic', 'benign recurrent adenoma', and 'wuchernde struma'. This type of growth, tending as it does to spread widely in the neck and to fill the mediastinum with a large solid mass of new growth, appears considerably more malignant either than it is or than its subsequent course usually indicates. When finally it becomes diffuse it does so by direct invasion rather than by any lymph metastasis.[46] Indeed, rupture into blood-vessels with blood transportation seems to be the dissemination stage of this neoplasm.* Secondary tumours formed in this way from tissue emboli reproduce *in toto*

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* *See* the classical case of von Eiselsberg.[47]

the form of the organ of their origin, and, moreover, show a functional potentiality unusual for metastases. These 'implants' can function as thyroid gland. They present a marked contrast to the metastases of veritable carcinomata—cellular seeds—which multiply into cancers that do not exhibit any functional power. These thyroid emboli are really 'organomata', resembling closely certain suprarenal tumours which spread in a similar way and exercise a similar functional power.

The surgeon naturally sees greater possibilities for cure in the eradication of any growth that is confined to the organ of its origin, and he is prepared to go to great lengths in surgical procedure so long as *cellular metastases* are not a feature of the neoplasm. Operation on thyroid neoplasms of the order which we have been describing should only be delimited by topographical difficulties due to the situation of the thymus. Perhaps the newer procedures —radium, etc.—may render this neoplasm more accessible.

Owing to the importance of this subject we propose to deal fully with thyroid cancers as a whole in a subsequent publication.

SUMMARY.

1. A special thyro-thymic lymph system is described as the essential and most primitive feature of thyroid anatomy.

2. The intra-thyroidal portion of this system consists of thyroid lymph sinusoids draining into intralobular lymphatics. These lymphatics, unlike those of the capsule of the thyroid, emerge from the substance of the gland at the *hilum* of each lobe.

3. The extra-thyroidal portion of this system consists of lymphatic channels proceeding from the hilum of the thyroid lobe to their termination in thymic tissue.

4. Thymic tissue occupies both neck and mediastinum, thymic nodes being liable to occur anywhere within a special deep fascial compartment of the neck extending from the base of the skull to the pericardium.

5. Structurally all thymic tissue is formed of the coiled plicated capillary terminals of the thyro-thymic lymphatics.

6. The thymus is thus essentially of the nature of a lymph reservoir to the thyroid gland.

7. A special secretion of the thyroid, which we have called *lymphogenic secretion*, is poured into the thyroid lymph sinusoids, and can, under appropriate conditions, be seen pervading the whole thyro-thymic lymph system.

8. The anatomical facts set out above are confirmed by embryological and phylogenetic studies of the thyroid apparatus.

9. In the most primitive thyroid known the naked epithelial follicles lie in a cavernous lymph-sac.

10. In the course of phylogenetic development this primitive lymph reservoir becomes the thymus of man.

11. In the primitive form the thyroid lymph reservoir receives its main tributaries from the gills.

12. In the primitive form the thyroid lymph reservoir drains, by a valved opening, directly into the heart.

13. Thus, the primitive thyroid lies in the effluent lymph coming from the gills and pharynx on its way to the heart, just as the liver lies in the effluent blood coming from the gut *en route* to the heart.

CLINICAL INFERENCES.

1. The thyroid and thymus must be regarded as one apparatus in all considerations of the thyroid function. Especially must this apply to the study of Graves' disease, thyrotoxicosis, and endemic goitre.

2. The lymphogenic secretion of the thyroid (which elsewhere we have shown to be responsible for thyrotoxicosis) is normally detoxicated in the thyro-thymic lymph channels. This explains the constant association of Graves' disease and thyrotoxicosis with status thymico-lymphaticus. It also explains the claims made for thymectomy in the treatment of thyrotoxicosis.

3. A reason is provided from comparative anatomy for the cardiac implications in thyrotoxicosis.

4. The thyro-thymic lymph system is a closed system. It has no connection with the cervical lymphatic glands into which the 'lymphæ comites' of the capsular veins of the thyroid drain.

5. Thyroid cancers may be divided into two main groups : (*a*) Those primarily invading the capsular lymphatics and extending to the deep and superficial cervical glands; and (*b*) Those primarily invading the thyro-thymic lymph system and extending into the thymus.

6. Thyroid cancer occupying the thyro-thymic lymph channels may appear in the neck or mediastinum, since this is the area over which thymic tissue is normally distributed. Under such circumstances the growth is still confined *within the organ of its origin* and is still capable of function. Such intrathymic nodules are not to be classified, *qua* malignancy, in the same category as the 'cellular seeds' of true metastases found in the ordinary lymph glands.

7. Certain features of the cystic hygromas of the neck suggest that these tumours have origin in developmental abnormalities of the thyro-thymic lymph system.

We have again to thank Sir Arthur Keith, Sir James Berry, Professor George Gask, and Mr. T. P. Dunhill for material, criticism, and help in the preparation of this work, which was done on behalf of the Medical Research Council.

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SHORT NOTES OF
RARE OR OBSCURE CASES

GIGANTIC BENIGN TUMOUR OF KIDNEY WEIGHING 22 POUNDS. NEPHRECTOMY: CURE.

BY G. GORDON-TAYLOR,

HON. SURGEON TO THE MIDDLESEX HOSPITAL, LONDON.

THE rarity of benign tumours of the kidney presenting features of clinical interest, together with the enormous size of this particular neoplasm, appear to justify the publication of this case on the eighth anniversary of the operation for its removal.

HISTORY.—Olive B., an unmarried lady of 20 years, was referred to me with the diagnosis of an intra-abdominal tumour. For four years she had noticed a gradual distension of her abdomen, but during the three months which immediately preceded her consultation with me in June, 1921, the enlargement had increased at a much more rapid rate. The menstrual history was normal, there were no changes in the breasts, and no mention was made of any digestive disturbances other than might readily be occasioned by the presence inside the belly of a mass of such dimensions as this tumour was found at operation to possess. The patient confessed a feeling of increasing lassitude, but her great complaint was of the inconvenience produced by the growing distension of her abdomen, which hampered freedom of movement, interfered with her games, and by imparting such amplitude and rotundity to her figure taxed to the utmost the skill and the art of the *couturière*.

ON EXAMINATION.—The abdomen was enlarged, and there could be felt a large tumour occupying the greater part of the belly; it extended upwards under the left costal arch and downwards into the left iliac fossa and the hypogastrium. The mass did not move on respiration, nor could it be displaced by manipulation through the abdominal wall. The uterus was pushed downwards by the weight and volume of the tumour, from which it could not be separated with any certainty on rectal examination. There were no abnormalities in the urine, but unfortunately no cystoscopic, radiographic, or pyelographic investigations were carried out. An exploration of the abdomen was clearly indicated and was performed in June, 1921.

OPERATION.—Under gas and open ether anæsthesia a left paramedian incision of generous length revealed the existence of a huge retroperitoneal tumour, over which coursed numerous large and dilated veins. The diagnosis of a retroperitoneal sarcoma suggested itself, but nevertheless there appeared to be possibilities of a successful extirpation of the mass. No difficulties of

exceptional character attended the liberation and delivery of the tumour; but it was only at the very last stage of the operation, when the neoplasm remained still attached to its bed by a relatively slender pedicle, that this latter was recognized as containing ureter and renal vessels. The left kidney seemed lost in the mass, which now came to be regarded as a malignant renal neoplasm. The right kidney was rapidly palpated, and the left-sided tumour was thereafter speedily freed and removed. The abdominal wall was closed and the patient returned to bed in fair condition after her severe operation.

Post-operative convalescence proved almost uneventful: the girl subsequently married, and is now the mother of three children. Her health
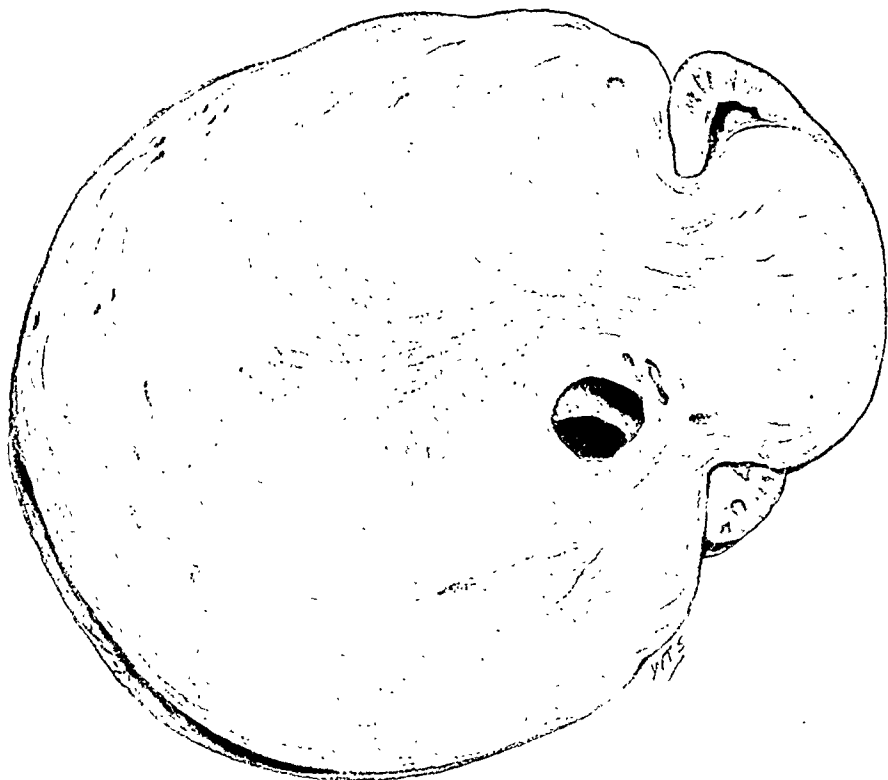
FIG. 345.—Adenofibroma of left kidney; nephrectomy; lips of hilum of kidney widely separated, permitting the escape of the tumour.

has been excellent since her operation, and it is now the eighth anniversary of the date on which she was freed from the weight and inconvenience of her huge encumbrance.

PATHOLOGICAL REPORT.—The tumour at the time of its removal weighed 22 lb., and the following report upon its naked-eye and microscopic character has been furnished me by Dr. S. L. Baker, of the Bland-Sutton Institute, Middlesex Hospital :—

The tumour appears to be an adenofibroma of the kidney of embryonic origin.
Macroscopically.—A firm rounded tumour measuring 13 by 11 by 5 in. At one end of the mass is seen the kidney, of which the poles only are intact, the remainder

being thinned out over the tumour surface. The tumour has the appearance of having grown from the region of the renal pelvis. The mass has a well-defined capsule, and the cut surface shows a whorled appearance and appears to consist of firm, fibrous tissue. In the region of the kidney are a collection of cysts ranging from a few millimetres up to 1½ in. diameter, the lining of which is studded with rounded papillary projections.

Microscopically.—The tumour shows a somewhat loosely arranged fibrous stroma, scattered about in which are fairly numerous tubules lined by cubical or rounded cells. There are also cysts lined by flattened epithelial cells. The general appearance suggests a fairly slow-growing benign tumour.

The appearances presented in *Fig.* 345 strongly suggest that the tumour originated in the vicinity of the renal sinus, as is remarked by Dr. Baker in
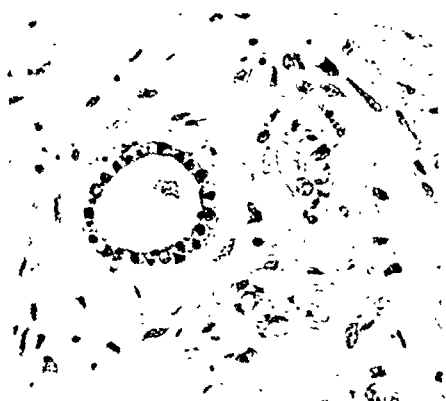
Fig. 346.—Microphotograph exhibiting a tubule which resembles those of adult type.

Fig. 347.—Microphotograph exhibiting a tubule of embryonic type.

his pathological report upon the specimen, and that growing externally it expanded and thinned out the kidney over itself. On the mesial aspect of the kidney the lips of the hilum can be seen widely separated to permit the escape of the tumour, which has undergone an exaggerated development on the concave aspect of the organ.

The histology, which exhibits tubules resembling those of adult type (*Fig.* 346) as well as several of embryonic character (*Fig.* 347), renders it difficult to label the tumour and its place of origin with absolute pathological exactitude; the admixture of different epithelial forms in the mass of fibrous tissue which constitutes the great bulk of the tumour (*Fig.* 348) is consistent with an origin from Wolffian remains in the vicinity of the hilum, but it must be borne

Fig. 348.—Microphotograph showing the fibrous tissue of which the main mass of the tumour is formed.

in mind that congenital anomalies are also met with in the kidney itself. In the latter "the existence of a variety

of structural defects is fully attested " (Ewing[1]), and it is unnecessary to go further afield than a consideration of the subject of adrenal 'rests' to find evidence of aberrant embryology in connection with the kidney.

Benign growths of the kidney are infrequent, and rarely present themselves as tumours for diagnosis. Renal fibromata are but seldom problems for the clinician, but in Bruntzell's[2] patient a fibroma is recorded which weighed as much as 20 lb., and Sir Henry Morris[3] refers to a case where a fibroma growing within the renal capsule attained a size approximating to that of a child's head. No record of an adenoma of the kidney of surpassing size has been exhumed from the literature. The tumour here reported would appear to be the *largest benign tumour of the kidney on record*.

It is noteworthy that benign renal neoplasms never attain the enormous dimensions presented by perinephric tumours, which constitute some of the very largest growths known to pathologists and surgeons. The perinephric tumours which have reached the most colossal size are the lipomata, which may be pure or may contain an admixture of tissues ; the perinephric fibromata are less frequent, and never attain the huge weight exhibited by the largest lipomata.

The largest perinephric tumour appears to be that reported by Hirsch and Wells ; this was explored, found to be inoperable, and at the autopsy weighed 69 lb. The following are the *largest perinephric tumours* arranged in the order of their weight :—

Hirsch and Wells	..	69 lb.
Billroth (reported by Salzer[4])		63·8 ,,
Waldeyer[5]	..	63 ,,
Homans	..	57 ,,
Vogelwied[6]	..	55 ,,
Cantoni[7]	..	55 ,,
Demoulins	..	53 ,,
Windle[8]	..	50 ,,

The specimens of Waldeyer and of Windle both came under notice as post-mortem trophies and contained a sarcomatous element. Many of the others recorded in the above list died as the result of surgical adventure.

The points of interest about the adenofibroma of the kidney reported in this communication are : (1) The huge weight of this benign renal tumour ; and (2) The good health of the patient eight years after the removal of the mass, the subsequent clinical history and the microscopic findings fortunately reversing the pessimistic opinion as to the nature of the tumour entertained and expressed at the time of the operation, when it was regarded as malignant in character.

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CASE OF RECURRENT DUODENAL ULCER AFTER PYLORECTOMY, AND THE FORMATION OF BONE IN A LAPAROTOMY WOUND.

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C. L., male, age 44, was admitted to St. Mary's Hospital on March 11, 1924.

HISTORY.—In 1917, while in the Army, the patient had recurrent attacks of epigastric pain and vomiting ; these occurred usually some hours after food, and the pain was relieved by the vomiting. Between the attacks he had intervals when he was entirely free from pain. As the pain was increasing in severity and frequency and he was losing weight, he came to hospital for treatment. He presented no physical signs on examination, but a radiograph after a barium meal revealed an ulcer in the region of the pylorus.

FIRST OPERATION.—He was operated on under general anæsthesia by Professor C. A. Pannett on March 13, 1924. Numerous adhesions were found about the pylorus, and an ulcer of the first part of the duodenum penetrating the pancreas. An excision of the ulcer-bearing segment of the duodenum and a small part of the antrum of the stomach was performed, followed by a Billroth I operation. Convalescence was uneventful, and the patient was discharged on April 3.

Reports of his condition were obtained in March, 1925, and in February, 1927. He had been free from pain and discomfort except on one occasion after a large meal of red meat and cheese. During this period he had existed on a liberal diet.
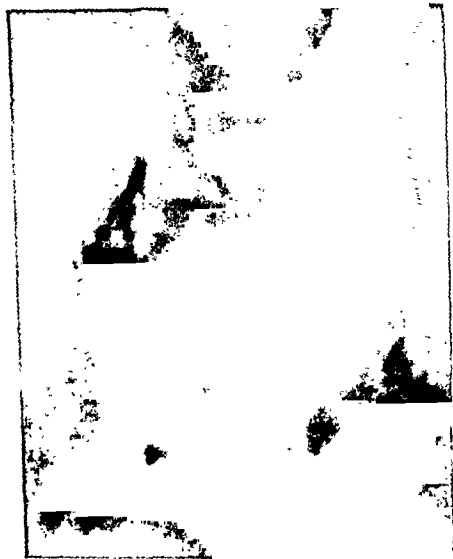
FIG. 349.—Radiograph showing the ulcer in the upper part of the duodenum.

On May 27, 1929, the patient was readmitted to hospital with the following history. He had had no symptoms until February, 1929, when he had a recurrence of his former attacks of pain and vomiting which lasted fourteen days. He had a further period of attacks early in May. On admission he was free from pain. X-ray examination after a barium meal showed evidence of an ulcer situated in the upper part of the duodenum. The radiograph reproduced (Fig. 349) shows this very well.

SECOND OPERATION.—An operation was performed under spinal anæsthesia by Professor Pannett on June 3. An ulcer of the posterior wall of the duodenum, adherent to the pancreas and surrounded by a mass of induration,

was found. Owing to the adhesions it was possible only to do an anterior gastrojejunostomy. No evidence of the original suture line could be detected.

Comments.—The interesting feature of this case is that for five years after the first operation the patient had experienced no symptoms whatever. This operation was performed at a time when it was not realized that the essential factor in the treatment of duodenal ulcer by excision is to remove a sufficiently large portion of the antrum of the stomach. Removal of too small an amount of the antrum is believed to be the explanation of the recurrence of the ulcer in the case recorded above. This view is supported by the observations of H. Jansen.[1] He collected from the literature on the subject 21 cases of recurrent ulcers after Billroth I (these are true recurrent ulcers and not peptic ulcers, which may follow Billroth II). Of these, 11 were suture recurrences and 10 were away from the gastroduodenal junction. In nearly all these there is sufficient explanation in the small resection of antrum carried out. In a few cases other predisposing factors, such as the use of silk thread, were concerned ; and others were ulcers which had been overlooked and may therefore be termed 'false ulcers'. Jansen states that there are two reactions essentially concerned in the neutralization of the gastric juice in the duodenum : (1) The reflux of the alkaline secretions into the stomach, which is controlled by the pylorus; and (2) The reflex inhibition of the gastric secretion caused by the presence of acid in the duodenum and jejunum. Of these the latter is by far the more important. Following this explanation, the operation most correct physiologically is Billroth I, with large resection of the antrum. After this operation the antrum, the excitor of the chemical secretory phase in the stomach, is removed and only psychic secretion remains. The inhibitory reflexes from the duodenum come into play unweakened and even strengthened, because the stomach chyme goes unchecked through the gastroduodenal opening, there being no sphincter. Furthermore, reflux takes place more freely.

A second interesting feature of this case is that about a month after the patient's first discharge from hospital he noticed the scar of his laparotomy wound had become indurated. It gradually became harder, and led to some discomfort when he bent forward. When he presented himself for examination in May, 1929, a hard cartilaginous-like area could be felt directly under and adherent to the scar. It was not attached to the xiphisternum or costal cartilages. At the second operation this indurated mass was found to be osseous, and to consist of two parts joined in their middle thirds and so arranged that one half was in front of and the other behind the inner border of the right rectus muscle. It formed, in fact, a gutter in which lay the inner border of the muscle. The piece of bone, of which a drawing is reproduced here (*Fig.* 350), was 9 cm. long. It was removed and part sectioned for microscopic examinations ; the pathologist's report stated that it was true osseous tissue.

Sir Arthur Keith,[2] in a survey of the literature, records 36 cases of the formation of bone in laparotomy wounds, 34 of which occurred in wounds in or near the supra-umbilical part of the *linea alba*. In the case here reported the incision was a right paramedian, the rectus sheath being divided and reflected off the muscle. The piece of bone was densely adherent to the sheath

near the linea alba. This formation of bone in wounds is explained by the theory that certain cells of the body other than those of the skeletal system, under certain circumstances, are able to take on osteoblastic function. The fact that in so large a proportion of the cases recorded the growth of bone
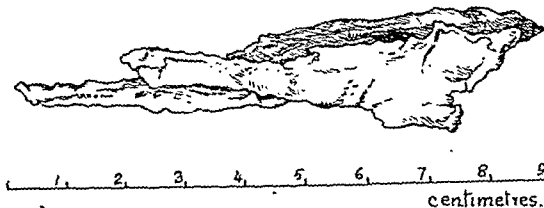
FIG. 350.—Osseous indurated mass that formed at the site of the laparotomy scar.

has taken place in the epigastric region, leads to the suggestion that cartilage cells set free by injury to some part of the costal cartilage may, under these circumstances, be able to take on bone-forming properties. In the specimen obtained in this case the thickest part of the bone was that nearest the costal margin, and here it would seem the growth of bone started.

My thanks are due to Professor Pannett for permission to publish this case, for the drawing produced, and for his assistance.

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A CASE OF ANOMALOUS KIDNEY PRODUCING SYMPTOMS.

BY R. K. DEBENHAM,

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ANOMALIES of the kidney itself may occur alone, but are more often found in connection with other anomalies of the urinary tract ; thus a kidney abnormal in form is often abnormal in position and is associated with abnormal vessels. Of the 38 anomalies of the kidney studied by Braasch,[1] 3 were ectopic kidneys. The frequency of ectopic kidney is shown by Naumann,[2] who in a collected series of 10,177 autopsies found 20 cases of this condition. Of these, 12 were on the left, 5 on the right, and 3 bilateral. The condition is more common in women than in men : Sträter[3] found that in 66 cases, 53 occurred in women and 13 in men.

The frequency of multiple renal arteries is shown by Brewer (cited from Seldowitsch), who found more than one renal artery on one side in 85 (56 per cent) of 151 cadavers. Of these, there were 70 which showed two renal arteries, 12 showed three, 2 showed four, and 1 showed five. Seldowitsch[4] found 43 cases of supernumerary renal arteries in 150 cadavers (30 per cent).

In 33 cases the supernumerary arteries were unilateral, in 10 bilateral. Anomalous renal arteries are the rule in anomalous kidneys, fusion forms, ectopic kidneys, etc. Ectopic kidneys only infrequently give rise to symptoms unless associated with other disease.[5] The case of anomalous kidney that is reported below produced symptoms at the age of 33, and was associated with hydronephrosis. Of 98 cases of unilateral single supravesical obstruction causing hydronephrosis, 3 were due to ectopic kidney and 1 to nephroptosis with aberrant vessels (Brady Institute cases[5]).
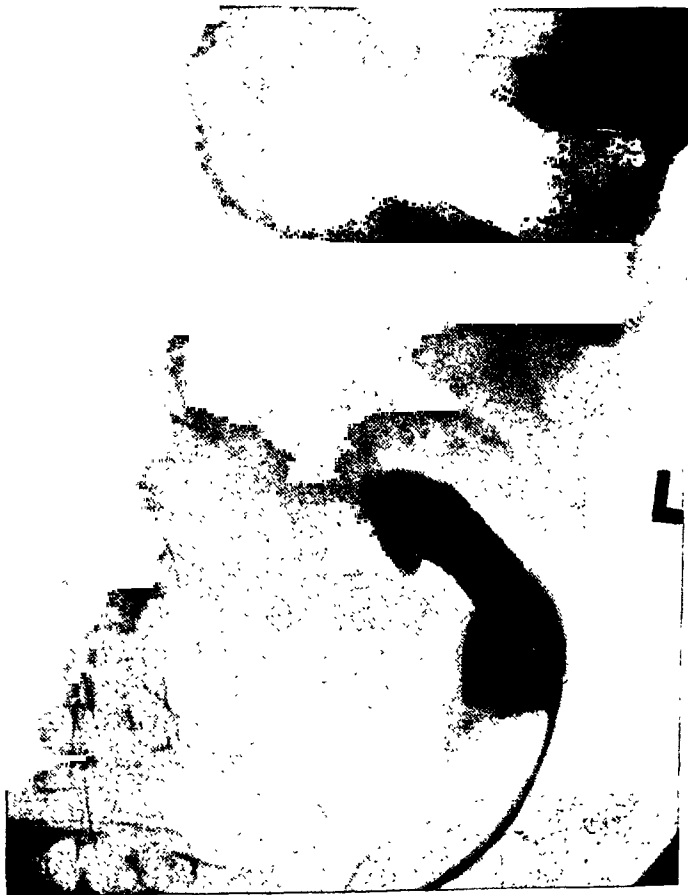
FIG. 351.—Pyelogram of left kidney.

The following case is reported as showing a very rare congenital condition of one kidney. The diagnosis lay between carcinoma of the colon and a renal swelling, a pyelogram being invaluable in deciding the question.

HISTORY.—The patient, a male, age 34, complained of pain in the left lumbar region, together with frequency of micturition, the symptoms being of nine months' duration. The pain was in the left lumbar region, and at a corresponding point in the front of the abdomen, extending forwards almost to the mid-line in the umbilical region and occasionally radiating down to the

left groin and testicle. It was a constant dull pain, with occasional severe exacerbations. There was increased frequency of micturition, twice at night and every hour or two by day. There was never any hæmaturia, the bowels were regular, and the previous health had been good, though there was a history of having passed bright red blood per rectum off and on for twelve months, ten years previously.

POSTERIOR VIEW.   ANTERIOR VIEW.

Fig. 352.—Showing the condition of the kidney. It was of approximately normal size. The pelvis emerged from the anterior surface of the kidney and was considerably dilated, the ureter arising from the outer side of the pelvis.

ON EXAMINATION.—The patient was a healthy, well-nourished Hebrew. In the left lumbar region there was a well-marked, easily palpable, smooth, firm swelling, extending slightly backwards into the loin ; it was lower than a normal kidney, the examining finger could be placed above the swelling, between it and the left costal margin ; the swelling was easily movable and not tender. The right kidney was not enlarged, and there was nothing abnormal on rectal examination.

The urine had a specific gravity of 1020, was clear, acid, with a slight

cloud of albumin, and showed leucocytes and epithelial cells on microscopical examination of the deposit.

An X-ray examination of the urinary tract was negative, the right kidney being normal in size. A barium enema showed no abnormality in the colon.

On cystoscopy the bladder and ureteric orifices were normal. A pyelogram of the left kidney was taken, 15 c.c. of sodium bromide being injected into the left kidney pelvis, when the patient experienced pain to the left of the mid-line in the umbilical region. The pyelogram showed considerable dilatation of the renal pelvis (hydronephrosis), and also apparent outward rotation of the kidney on its axis, so that the ureter emerged from the pelvis on the outer side (*Fig. 351*). The right kidney was found to be healthy and the pyelogram normal.

OPERATION.—*Exploration of the left kidney was advised and undertaken by Mr. Hugh Lett.* The kidney was exposed by the usual lumbar route, the incision being made rather lower than usual. The organ was found to be low, and partly in the left iliac fossa, the left suprarenal being in the normal position. *Fig. 352* shows the condition present.

The main renal vein left the kidney at the hilum, which was on the anterior surface. A small artery entered the hilum at the upper part, but the main arterial supply entered the posterior surface of the kidney, one and possibly two vessels coming from the left common iliac artery. One small artery with a large vein passed behind the posterior surface of the kidney, curved round the outer side, and entered the hilum on its external aspect; these vessels appeared at the operation to be constricting the kidney about its centre. Nephrectomy was performed.

SUBSEQUENT PROGRESS.—When seen two months later the patient had lost all his symptoms ; he had had no pain, had gained 8 lb. in weight, and his frequency of micturition was normal. There was no lump to be felt on examination, and he has remained well ever since.

I am greatly indebted to Mr. Hugh Lett for allowing me to report this case, and also to Dr. Donald Hunter under whose care the patient was originally admitted.

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REVIEWS AND NOTICES OF BOOKS.

Lehrbuch der diagnostischen und operativen Cystoskopie. By Dr. EUGEN JOSEPH, of Berlin. Second edition. Royal 8vo. Pp. 254 + vii, with 290 illustrations, some in colour. 1929. Berlin : Julius Springer. Paper covers, RM. 48 ; bound, RM. 51.

THOSE who have read Dr. Joseph's book *Die Harnorgane im Röntgenbild* will know that he is an enthusiastic urologist, deeply interested in the developments of pyelography, and an excellent writer ; they will look forward to reading this new edition of his work on cystoscopy, and they will not be disappointed. The first edition of the present work was brought out in 1923, and was then called *Kystoskopische Technik.*; during the intervening period the author has devoted himself more especially to improving the technique of operative cystoscopy, and has accordingly modified the title of his book.

In the 254 clearly printed pages of this text-book, the surgeon and the urologist will find an excellent account of the technique of cystoscopy, of the various conditions of the bladder revealed by this instrument, of the author's method of making pyelograms, and of his opinions on the estimation of kidney function. In the last fifty pages will be found an account of the latest developments of operative cystoscopy— the fulguration treatment of bladder tumours, the crushing of vesical stones under the control of the (cystoscopic) eye, and various endovesical procedures in disease of the prostate and of the bladder neck. The illustrations are numerous, good, and to the point : they include a number of clearly reproduced pyelograms and some very helpful diagrams. The author gives a short and lucid sketch of the optical mechanism of the cystoscope, and points out that it is not necessary to go more deeply into the science of optics, " since a U-boat can be navigated without a knowledge of the optics of the periscope ".

Whilst the reader will find few startling novelties in this work, it can probably be taken as an expression of the teaching of the modern German school of urology, and it may be of interest to compare some points of the author's practice with those prevailing in this country. Under the still vexed question of anæsthesia, we note that Dr. Joseph hardly ever uses a general anæsthetic for cystoscopy : he considers that it interferes with the function of the kidneys and invalidates the findings of the various methods of estimating their efficiency. He never employs cocaine for urethral and bladder anæsthesia, for he once saw, as an assistant, a death which was undoubtedly due to this drug : he thinks that alypin is the safest and most reliable anæsthetic for this region, though he appears to have lived through one or two alarming experiences even with this. He states that sacral anæsthesia is less toxic but also less certain than spinal : it can be easily carried out in thin patients, but is often impossible and uncertain in the adipose. Although he does not approve of taking pyelograms in the out-patient clinic, he has frequently had to do so owing to the shortage of beds, and he has not seen any serious sequelæ.

Of the appearances described as seen by the cystoscope, by far the most interesting is what he calls 'Schramm's phenomenon': as this has not yet crept into the English text-books, we will give a short résumé of his remarks on this subject. This phenomenon is described under the heading of the trabeculated bladder, and it consists in the possibility of seeing, with a cystoscope of average calibre, certain details of the prostatic urethra, such as the verumontanum, the openings of the prostatic and ejaculatory ducts, etc. When this phenomenon is present it is an almost certain sign of disease of the central nervous system : its absence, however, does not

preclude the existence of such disease.   As a proof of its reliability, the author quotes the case of a man whom he cystoscoped some time after the fulguration of a papilloma of the bladder ; there was no sign of the tumour, but Schramm's phenomenon was noticed quite accidentally ; the patient was sent on to a neurologist, who reported that he was suffering from locomotor ataxy with characteristic loss of tendon reflexes. As this seems to be still another of the pre-ataxic signs of this disease, the observation would well deserve following up.

Under the heading of the estimation of kidney function, the most striking fact brought out is that Rehn, in answer to a questionnaire as to the relative frequency of the various tests used in German clinics, found that chromocystoscopy not only heads the list but is employed almost twice as often as any other test ; the two next in frequency are cryoscopy and the water and concentration methods.

In view of the opinions expressed by recent English writers as to the causation of hydronephrosis, it is quite refreshing to find that Dr. Joseph is a firm believer in the old theory that movable kidneys and abnormal renal arteries are real and potent causes of this condition ; he gives some convincing pyelograms in support of this. He is quite enthusiastic on the subject of the crushing of vesical stones under the control of the cystoscopic eye, and he says that this procedure is not only extra-ordinarily safe but is not particularly unpleasant for the patient.

We can recommend this book for a place in the library of urologists and of those surgeons who are interested in cystoscopy.

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The Preparation of Catgut for Surgical Use.   By W. BULLOCH, L. H. LAMPITT, and J. H. BUSHILL.   Special Report Series, No. 138.   Medical Research Council of the Privy Council.   Royal 8vo.   Pp. 178, illustrated, 1929.   London : H.M.S.O.   4s. net.

THE value of the researches described in this publication can be estimated by recog-nizing their direct bearing upon the practice of surgery, and by considering how many may benefit by the investigation.   To those who have a living interest in the craft of surgery the mere title of the Report, associated with the name of William Bulloch, is sufficient to indicate its fundamental importance, and a sufficient stimulus to study its pronouncements with care.   To those who feel they have already attained perfection the observation that the vast majority of catgut ligatures sold as sterile in the open market proved to be infected when examined bacteriologically must come as a disquieting thought.   To the whole profession and to the public, it will be reassuring to learn that surgical catgut is to be controlled under the Therapeutic Substances Act, the data of this Report having been directly useful in the guidance of administrative action.

As the Council points out in the Preface, the work stands in historical succession to the classical studies of Lister.   In addition, however, to the description of a prodi-gious amount of experimental work upon the bacteriology and physical properties of catgut, the Report contains the most complete modern account of the history and literature of the whole subject.   An investigation of this magnitude demands painstaking study, and the authors deserve our gratitude for the clarity with which they have formulated their conclusions.

The first part, by Professor Bulloch, deals with disinfection ; the second, by Dr. L. H. Lampitt and Mr. J. H. Bushill, of the Research Laboratories of Messrs. J. Lyons and Co., describes the physical and chemical properties of sheep's intestine and the effects upon them of iodine sterilization.

Commencing with an extremely interesting historical survey of the use of catgut in surgery. Professor Bulloch records that after being employed in ancient times it fell into disuse, to be reintroduced in 1816 by P. S. Physick, of Philadelphia. who was at one time House Surgeon to John Hunter.   Lister's contributions to the subject, extending over forty years in the latter part of the last and the beginning of the present century. may, however, be considered as inaugurating the modern period.   A synopsis is given of the observations upon disinfection made by Lister and his contemporaries, and of the perplexities and discrepancies which they encoun-tered in their investigations.   The historical review ends with the ·iodine period', introduced by Claudius in 1902.

A description is given of the anatomy of the sheep's intestine, and of the processes it passes through in the production of catgut ; and it is pointed out that if catgut intended for surgical use were prepared separately from that intended for other purposes, a comparatively small amount of extra care would diminish enormously the initial bacterial contamination of the raw product. Under present conditions the submucous coat of the intestine, originally sterile, becomes excessively infected in the slaughter-house, the infection being intensified by subsequent soaking in alkaline watery solutions.

The technique of testing the sterility of catgut is then discussed, and the writer insists that when the gut has been treated with antiseptic the action of that antiseptic must be annulled before the bacteriological test is made, as otherwise its inhibiting action may give deceptive results. 'Sterile' catgut washed in water to remove the fluid in which it has been stored, will frequently fail to grow anything on culture. But if the antiseptic incorporated in the catgut be removed before the culture is made, organisms will be grown from many samples sold as 'sterile'. It is by this technical step that Professor Bulloch has been able to prove so many samples to be infected, and though nobody would question the validity of his argument as regards the bacteriological experiment, the relative importance of this factor in regard to catgut buried in the human body may be doubted. That the author is alive to this aspect of the problem is shown by the only flight of fancy which he allows to creep into the scientific inquiry. While pondering over the thought that if catgut usually contained pathogenic bacteria it would have been discarded years ago, he admits that " a ligature charged with a chemical disinfectant has been held to be protected against infection during its career of activity " ; and " it might indeed be argued that a small number of bacteria in catgut might have some definite antigenic effect and promote some slight reaction which was not necessarily detrimental ".

The organism most commonly found in catgut is *B. mesentericus ruber*, which is extremely resistant to chemicals and heat, but is apparently non-pathogenic. Those who are responsible for the well-being of patients will not readily be comforted by the assurance that the organisms are not virulent. It has frequently been observed that even the finest catgut sutures if placed close beneath a skin incision give rise to a reaction which appears about a week after the operation, accompanied by an exudation of serum which, though not infected with pyogenic organisms, interferes with healing, and may be attributable to so-called 'non-pathogenic' bacteria. Also it is not unreasonable to assume that where non-pathogenic organisms occur the probability of the appearance of pathogenic bacteria is greatly increased ; and it has been shown that a mixture of two strains of organisms, individually harmless, may produce generalized sepsis in animals. The presence of non-pathogenic bacteria is not, therefore, to be regarded as unimportant. On the other hand, Professor Bulloch, when reviewing the literature of catgut infections in man, comes to the conclusion that little of it will bear scrutiny, and that 'catgut infections' usually rest on clinical conjecture.

Even in the extremely interesting and critical survey of the literature on post-operative tetanus, he states that " although there may be a suspicion against catgut it remains for the most part only a suspicion. In almost all the cases of 'catgut' tetanus there have been other sources of infection which have either been left unconsidered or have not been adequately differentiated before the diagnosis of 'catgut' tetanus was made ". One point which may be of much importance in regard to tetanus is that it has been confined almost entirely to abdominal operations.

The bulk of the original experimental work recorded consists of a large number of tests for sterility of samples of catgut treated with various disinfectants. So many variable factors had to be considered that the undertaking has assumed gigantic proportions ; and the results of the investigation are certain to modify many of the reader's previous impressions with regard to the efficacy of certain bodies as disinfectants. Starting with carbolic acid and the mercurial compounds, he examines chromic acid, the silver compounds, several oils, formalin, and picric acid in turn. It is not till he comes to hydrogen peroxide, and especially to aqueous solutions of iodine, that he obtains chemical sterilization which could be adapted to the

preparation of catgut on a big scale. As a result of many hundreds of experiments he is able to confirm the claims of Claudius that 1 per cent aqueous solution of iodine and potassium iodide applied for eight days will sterilize the most contaminated catgut. That the solution must be aqueous and not alcoholic is shown by the fact that 1 per cent *iodine in absolute alcohol* will not sterilize ligatures in forty days. The watery solution apparently enables iodine to penetrate catgut and even the spores of bacteria, the only disadvantage of the method being the deterioration which takes place in the tensile strength when ligatures are kept in iodine for a prolonged period.

Apart from the chemical methods, catgut may be sterilized by heat. Provided the material is absolutely dry it can be sterilized by hot air, but there is still a risk of its deteriorating as a result of the treatment. Heating in alcohol is efficient only in the presence of water, and this method cannot be followed since the combination of water and heat ruins the catgut as a ligature.

Sterility is not the only requirement, and in the second part of the Report Dr. Lampitt and Mr. Bushill describe their studies of the effect of disinfection upon the tensile strength of ligatures. They draw attention to the importance of the reaction of the liquids in which catgut is washed, acid preventing degradation but reducing tensile strength, whereas an alkaline wash increases it. They show that iodine treatment tends to make a ligature more brittle, and that the presence of an acid (presumably hydriodic acid) is responsible for the reduction in tensile strength. This change may be reduced or eliminated by the addition of potassium iodate.

They also refer to the disadvantages of prolonged treatment with iodine, and recommend that the excess of iodine be removed and the ligatures stored in 70 per cent alcohol, to which glycerol may be added to maintain the flexibility of the ligature.

Their contribution includes observations with regard to the method of spinning the ribbons in order to obtain optimum strength ; and they were also able to prove that ligatures wound on glass tubes and immersed in iodine—thus being under tension during treatment—were distinctly stronger than those which were merely looped before being placed in the solution.

It is felt that this Report contains all the information about surgical catgut that is required to guide those who will be called upon to control its preparation in future. And it is to be hoped that as a result of the labours of Professor Bulloch and his collaborators the ideal ligature—sterile, strong, supple, and absorbable—may take the place of the article which at present, even when *coming from the most* reputable sources, is not above suspicion.

La Pratique chirurgicale illustrée. By VICTOR PAUCHET. Fasc. XIV. Royal 8vo. Pp. 239, with 178 illustrations by S. Dupret. 1929. Paris: Gaston Doin et Cie. Fr. 65.

IN this volume Victor Pauchet is assisted by Leon Monier, who contributes an article on dental surgery, and by M. P. Mornard, who writes on myeloma of the mandible, plastic elevation of the mammary glands, and on face-lifting. No doubt there is a demand for procedures which remove wrinkles, but the operation is not without risk. We have seen an operation of this nature followed by partial facial paralysis. A face robbed of its expression seems a poor substitute for wrinkles.

L. Bérard contribute a two-page article on Albee's operation, with twenty-four illustrations. P. Petit-Dutailles describes an elaborate procedure for uterine prolapse which combines amputation of the cervix, vulvovaginal perineorrhaphy, suture of the levatores ani in front of the rectum and beneath the bladder, and shortening of the round ligaments. The method is extremely well illustrated. Victor Pauchet writes on exophthalmic goitre, cirrhosis of the liver simulating cancer of the stomach, gastrectomy for high gastric ulcer, trans-meso-colic posterior gastrojejunostomy, hemicolectomy for intussusception secondary to carcinoma at the ileo-caecal valve, chronic inflammation of the great omentum, nephrectomy for hydronephrosis, and chronic suppuration of inguinal glands. All these articles are up to the usual high standard of his work. They represent for the most part standard surgery.

As in former volumes, the illustrations by S. Dupret are the great attraction, and they speak for the text.

Principles and Practice of Minor Surgery. A Text-book for Students and Practitioners. By EDWARD MILTON FOOTE, A.M., M.D., Visiting Surgeon, St. Joseph's Hospital, etc.; and EDWARD MEAKIN LIVINGSTONE, B.Sc., M.D., Assistant Visiting Surgeon, Bellevue Hospital, etc. Sixth edition. Pp. 787 + xl, with 420 illustrations. 1929. London and New York: D. Appleton & Co. 35s. net.

No book on minor surgery which we have read so completely fills its self-appointed rôle as does this volume. In this, the sixth edition of the work, Dr. Foote has had Dr. Livingstone as collaborator and part author. Their aim has been to cover the whole ground of minor surgery both in general surgery and in the specialties.

The book is divided into three parts. Part I deals with Minor Surgical Technique, and gives a lucid account of the principles and practice of asepsis, bandaging, surgical apparatus, anæsthesia, and minor operations. There is also a particularly valuable chapter, entitled, "The Manœuvres of Minor Surgery", which deals with sutures and the tying of knots. It is a chapter such as the young surgeon frequently looks for in text-books, but rarely finds. The sections are very well illustrated with easily understandable photographs.

Part II deals with the Principles of Diagnosis and Treatment, and gives broad clinical studies of groups of diseases—inflammations, wounds, specific infections, including tubercle and syphilis, and congenital defects.

Part III is written regionally and deals with the Practice of Minor Surgery, and occupies two-thirds of the book. It gives concise accounts of minor affections of the head, neck, trunk, genito-urinary organs, rectum, arm and hand, leg and foot: and each section is subdivided into injuries, inflammations, tumours, and deformities. While some of the sections on diagnosis are somewhat sketchily done—as in the description of some of the fractures—the sections on treatment are written with great care, the authors' personal views being clearly stated, but due prominence being given to all modern methods which are effective. There are a few omissions, but in general they are not serious ones—for instance, in the section on boils (p. 373) treatment by cupping is omitted.

The chief criticism we would offer is that at times the authors make excursions into regions which we would describe as major surgery. But, after all, the dividing line is a broad one, and, taking the book as a whole, the division between minor and major is very well kept. The work is an established favourite, and we have no hesitation in saying that it will prove of great use to new generations of senior students and young surgeons dealing with casualty and out-patient cases. It would be invaluable on the shelves of a general practitioner. The book is very well produced, the photographs are carefully chosen, and there is a comprehensive index.

Orthopædic Surgery. By Sir ROBERT JONES, Bart., K.B.E., C.B., Ch.M. (Liverpool), F.R.C.S. (England, Ireland, and Edinburgh), F.A.C.S., Emeritus President, British Orthopædic Association, etc.; and ROBERT W. LOVETT, M.D., F.A.C.S., late John B. and Buckmaster Brown Professor of Orthopedic Surgery in Harvard University. Second edition, revised. Crown 4to. Pp. 807 + xvi, with 792 illustrations. 1929. London: Humphrey Milford. £2 12s. 6d. net.

EXTENSIVE alterations have been made in the second edition of this book, and three new collaborators, Dr. Allison and Dr. Ober from America, and Mr. Harry Platt from England, now assist Sir Robert Jones. The alterations take the form of omissions as well as additions. It is, perhaps, a good point that some of the more special operations, such as those for reconstructing the external lateral ligament and crucial ligaments of the knee, have been left out. These operations are not very often required, and can quite well be looked up in their original descriptions. It might be possible to suggest further omissions of the same character. The additions to the book all improve its value. The short account of osteomyelitis, in which Mr. Platt's hand can be recognized, gives one of the best descriptions of this important condition to be found anywhere in literature. Instead of dealing only with mal-union of fractures, a chapter has now been introduced which includes a brief general account of fracture treatment. In view of the fact that the orthopædic

specialist has been called upon more and more to treat recent fractures, it may be expected that inclusion of this subject will be essential in orthopædic text-books in the future. There are many other additions of value ; but the last new chapter, that on amputations and artificial stumps, has been kept so brief that it can scarcely be considered to serve its purpose.

In a work of such size and elaboration there is naturally much to criticize, and perhaps the most obvious point is that the multiplicity of authorship sometimes prevents a clear and dogmatic statement of opinion, so that although the experienced orthopædic surgeon may be able to get valuable statements of varying ideas and methods, the less experienced student may find it difficult to get a perfectly clear view of some of the subjects. Treatment of tuberculosis of the hip is a case in point ; the treatment of the Boston School and of the Liverpool School is described. The single Thomas's hip splint, which in most clinics is looked upon as obsolete, still remains, and under the account of traction a discussion of opinions is given which really leaves the reader undecided as to the exact place and value of the method. The illustrations are increased in number by nearly a hundred. Actually the new illustrations are more than this, because many old ones have been omitted. There are, however, still illustrations which might be left out or replaced with benefit. A few of the radiographs are far from clear, and several have been wrongly inserted.

These points of criticism are, however, minor matters, and only point to the fact that, however excellent a book may be, it is generally susceptible of improvement. The work remains one of the best orthopædic text-books available, suitable both for students and for orthopædic specialists. There is very little in orthopædic surgery that is not adequately included.

Introduction to Anatomy. By N. S. SAHASRABUDHE, M.S., Lecturer in Anatomy, R.M. School. Nagpur ; Prince of Wales Fellow and Medallist, Bombay University (1926–7), etc. With Foreword by Dr. Y. G. NADGIR, M.S., F.C.P.S., Professor of Anatomy and Embryology, Grant Medical College, Bombay. Crown 8vo. Pp. 229 + vii. Illustrated. 1929. Nagpur : R. T. Deshmukh.

THE author states that it has been his endeavour to help students when beginning the study of human anatomy. He has certainly fulfilled his object, even " though parts of the book may be regarded as too elementary to justify their inclusion." He shows how knowledge of the medical curriculum may be applied to the elucidation of others, as when he demands of the student that he shall make use of his knowledge of physics in his study of the structure of the human body, in the comparison of the architecture of the human skeleton to the formation of an arch. Throughout the small volume the student of anatomy is constantly urged to ask himself the questions ' how and why ? ' This is surely anatomy taught from the right angle. We can only regret that the author has been so modest in his aims, as a volume of advanced anatomy written on the same lines would have a definite surgical value.

Surgical Pathology. By CECIL P. G. WAKELEY. F.R.C.S., F.R.S.E., Hunterian Professor, R.C.S. England ; Junior Surgeon, King's College Hospital ; and ST. J. D. BUXTON, M.B., B.S. (Lond.), F.R.C.S., Junior Surgeon and Junior Orthopædic Surgeon, King's College Hospital. Medium 8vo. Pp. 904 + xvi, with 392 illustrations, many of which are fully coloured. 1929. Bristol : John Wright & Sons. 45s. net.

THIS is a big book, measuring 9½ in. by 6½ in. There is a full table of contents, a list of illustrations, and an index occupying 39 pages. The work is intended to cover the whole field of surgical pathology, as one would expect from its size. The arrangement is like that found in several of the well-known text-books on surgery, and it suggests that the clinical matter from such a work has been deleted and the pathological sections somewhat elaborated. The first nineteen chapters are devoted to a general consideration of pathological processes and some specific conditions, and the remainder of the book—extending to fifty-six chapters—is arranged on a regional

basis. The illustrations are copious and, in most cases, very good indeed. Some of the coloured pictures—such as *Fig.* 7, an illustration of moist gangrene of the foot—are really beautiful. Other of the illustrations are not so good, and several are ill-chosen. *Fig.* 22 showing a penile chancre is quite an interesting example of such a lesion, but it is not the characteristic situation for a chancre on the penis. The illustration of a gummatous testicle (*Fig.* 372) is poor, and surely a better example not would have been very easily obtained. *Fig.* 389, representing a hydrosalpinx, is distinctive and ill compares with the very good picture of tubal mole on a near-by page. *Fig.* 232, called ' Pott's puffy tumour ', is so obviously misnamed that it makes one look for the table of Errata which, by-the-by, does not exist. It is clearly an example of ' Cock's peculiar tumour ', and bears no resemblance to the condition associated with the name of Percivall Pott, which, after all, is a condition only subject to diagrammatic representation.

In the section devoted to syphilis the condition of epiphysitis is merely mentioned under the head of congenital syphilis, and though it is briefly dealt with in the section devoted to diseases affecting the skeleton, there is no cross-reference to guide the reader. This want of cross-references is constantly felt by the reader, and their absence undoubtedly does the book some injustice.

It is scarcely enough to say of malignant tumours that " They are irregular and have no capsule. They invade the surrounding tissues. They form secondary growths (metastases) in other parts, and tend to recur if removed. . . ." Surely the fact that if unrestrained they ultimately destroy life is the criterion of their true nature. Chordoma, we are informed, " occurs in the region of the notochord, more commonly the anterior end, at the base of the skull ". Surely a little more precise information is necessary, and it would have been well to refer to those very carefully recorded cases where this interesting tumour occurred at the caudal end of the body. It is surprising to read that " a true lipoma probably arises in the dura of the skull, and may cause cerebral compression ; or if present in the spinal canal, it may cause signs of compression paraplegia ". Such a statement would have been more useful if it had been authenticated by a reference, but these appear to have been purposely and rigidly excluded throughout the work.

The book contains some loose statements and contradictions. For instance, in the section on myeloma, it is stated that in the lower limb the sites of election are " the upper end of the tibia, the lower end of the femur, and perhaps the upper end of the fibula or patella ". But in dealing further on with tumours of bones, under the same heading, the reader is informed that the patella is among the rare sites to be distinguished from the places of election.

In talking of bone cysts, we read that " multiple hydatid cysts may occur in bones, a conglomeration of daughter cysts with no mother cysts is found ". This is true enough, but is a statement which must leave the uninitiated in some considerable doubt as to the features of hydatid disease in bone. It is true that there is a poor illustration of hydatid affection of the femur and tibia on a distant page, but this is not referred to in the text nor in the index under hydatid cysts. There are only six words of description, and there is no mention of pathological fracture. This subject of hydatid disease illustrates the labour of using the book largely due to the omission of cross-references either in the text or in the index.

The important subject of cardiospasm is only allotted six lines and, as may well be judged, there is no real account of the condition, nor any discussion as to its possible causation. Similarly, the section on duodenal ulcer is very poor and occupies only one page, while gastrojejunal ulcer, with all its multitudinous possibilities, fares no better than cardiospasm, with only six lines. Pylephlebitis receives similar scant attention. The section on the pancreas is also disappointing. One looked for a reasonable account of inflammatory effusions into the lesser sac, but that interesting condition is merely dealt with in a few lines, and without any reference to the name of Jordan Lloyd. Under the heading of cysts affecting the pancreas there is no mention whatever of this condition.

In a book of this size one would naturally expect to find most of the available knowledge with regard to surgical pathology, and if that had been provided the authors might be excused for many of the omissions on debatable points. Of all the

sections in the book that on the ear, nose, and throat is certainly the best, and it is a relief to turn to its well arranged pages and succinct descriptions.

Nevertheless, in spite of all that has been said, let us hope that the authors will not be entirely discouraged, for there is still a demand for a really good work dealing with surgical pathology in the English language, and their book certainly provides a framework. It is because we realize that this framework is essentially good, and that the number of illustrations with the accuracy and beauty of their reproduction is so notable, that we feel it necessary to be critical about errors and omissions, which, after all, are matters of detail easily susceptible of amendment.

Hydatid Disease : its Pathology, Diagnosis, and Treatment. By HAROLD R. DEW, M.B., B.S., F.R.C.S., F.A.C.S., Hon. Surgeon to Out-patients, Melbourne Hospital, etc. Royal 8vo. Pp. 429, with 87 illustrations. 1928. Sydney : The Australian Medical Publishing Co. Ltd.

" THIS book marks the culminating point in a series of researches on the biology, pathology, and diagnosis of hydatid disease which, initiated by Dr. N. H. Fairley, have been carried on at the Hall Institute during the past five years." " The greater part of the researches embodied in the book have been carried out at the Walter and Eliza Hall Institute of Research in Pathology and Medicine, Melbourne." These words from the preface sufficiently show the origin of the book. The first seven chapters treat of the history, etiology, and prophylaxis, the geographical distribution, development, and general pathology of hydatid disease, with special reference to Australian conditions. Then follow chapters on special diagnostic methods and hydatid anaphylaxis. The last eighteen chapters describe the disease as it occurs in the liver and other parts of the body. Full regard is given throughout the book to the wonderful work of Dévé, of Rouen, to whom more than to any other individual the elucidation of the exact development of the cyst in man is due.

To those of us who see so little of the disease in this country the description of hydatids in Melbourne is a revelation. The presence of the disease wherever sheep-rearing is practised on a big scale is shown to be due to the careless manner in which fresh offal from slaughtered animals is left for dogs to consume. As sheep-rearing has spread to other countries than Australia—South America, for example—so hydatid disease has become frequent in man. The old theory that watercress is the causative factor is shattered by proof that ova are almost invariably spread to man through actual contact with dogs. The possibility of ova living over long periods of intense cold and great heat in wet or dry surroundings and of being air-borne into water-supplies is carefully considered.

The development of the cyst is minutely described with admirable illustrations, and an attempt is made to show how daughter cysts come to be developed. The chapters on treatment are well done. The preliminary injection of formaldehyde before emptying a cyst is still the favourite preventive of local infection ; the intro-duction of black cloths to pack off the area enables the operator to recognize escaped brood capsules more easily and remove them. That vexed question of how to deal with the cavity left in the liver after removal of the cyst is fully dealt with, though in this, as in other details of treatment, there is nothing new.

The book is well written and beautifully illustrated. It is easily the best work on hydatids in our language.

The Treatment of Fractures. By LORENZ BÖHLER, M.D., Chief Surgeon and Director of the Vienna Accident Hospital. Authorized English translation by M. E. STEINBERG, M.S., M.D., of Portland, Oregon. Pp. 185 + x, with 234 illustrations. 1929. Vienna : Wilhelm Maudrich. 21s. net ; $5 ; R.M. 21.

FOUR years ago a special hospital was established in Vienna that was devoted exclu-sively to the treatment of injuries. This hospital, which now contains one hundred beds, forms part of the organization of the Vienna Insurance Company, and is

responsible for the treatment of accidents in a considerable population of workers in Vienna and lower Austria.

Dr. Lorenz Böhler, the Surgeon-in-chief to the hospital, has already gained a world-wide reputation both as an exponent of the art of fracture treatment and as a surgical teacher. The methods he has used with great success are now fully described in a volume of less than two hundred pages adequately translated into English by Dr. M. E. Steinberg, of Portland, Oregon. In his preface Dr. Böhler states that success in treatment depends not only on the surgeon's skill but also on organization. The truth of this observation is obvious to all who have witnessed the team work of the Vienna Insurance Hospital.

Böhler is an apostle of the doctrine of rest, and his teaching is strongly tinged with the principles which in this country we associate with the names of Hilton and Hugh Owen Thomas. Local anæsthesia is used for the reduction of the majority of fractures, the hæmatoma and tissues around the bone-ends being infiltrated with 2 per cent novocain. Skeletal traction by Steinmann nails or ice-tong calipers is employed in the lower limb not only for compound injuries but also for many of the simple fractures. Early walking in a plaster-of-Paris cast applied without any skin covering is practised, and on removal of the cast a zinc, gelatin, and gauze dressing is applied from the toes to below the knee, which effectively prevents œdema. In compound fractures, after débridement of the wound, the skin only is sutured and all wounds are exposed to the air. Upper limb fractures even when involving the hand are treated with the limb elevated. Active movements are encouraged early, but passive movements are condemned. Massage and electrical stimulation of muscles play no part in the armamentarium of Böhler's clinic.

Perhaps the most striking section of this book is the one dealing with fractures of the os calcis, a subject to which the author has made a most original contribution. A method is described in which the displacement is corrected and the broken bone remoulded accurately. Strong traction is first applied to the posterior end by means of an ice-tong caliper, counter traction being maintained by a caliper gripping the shaft of the tibia. After the length of the bone is restored, the lateral expansion is corrected by powerful compression below the malleoli exerted by a special 'redresseur'.

No surgeon who is treating fractures seriously can afford to overlook Böhler's monograph.

Museum, Royal College of Surgeons of England. Guide to the Surgical Instruments and Objects in the Historical Series with their History and Development. By C. J. S. Thompson, M.B.E., Hon. Curator of the Historical Section of the Museum. With a Foreword by the Conservator, Sir Arthur Keith, M.D., F.R.C.S., F.R.S. Issued by order of the Council. Demy 8vo. Pp. 92 + iv. Illustrated. 1929. London : Printed for the College and sold by Taylor and Francis, Red Lion Court, Fleet Street. 2s. 6d. net.

" Three removes are as bad as a fire ", says the collector of unconsidered trifles. " By no means," replies his wife, " three removes are as good as a fire ", for in this manner she gets her cupboards cleared out and the miscellaneous collection of years, spoken of by her in modern phraseology as 'junk', makes way for a fresh collection. The Royal College of Surgeons of England has never moved in the 130 years of its corporate existence, nor has it been subjected to the ordeal of fire. Its cupboards, therefore, are stuffed full of presents given by its numerous friends. It has recently obtained the services of Mr. C. J. S. Thompson, M.B.E., who did much to build up the wonderful Wellcome Historical Medical Museum, and whose name is well known as the writer of a series of books on Alchemy, Magic, and the Art of the Apothecary. Mr. Thompson has a perfect genius for unearthing objects of medical interest and for describing them in such a manner as to be interesting alike to the doctor and to those who have no medical knowledge. A few years ago the late Mr. Alban Doran described in detail the various instruments preserved in the College Collection, and his valuable typewritten catalogue is preserved in the Library. Mr. Thompson has now produced a guide to the same collection based on general lines and in a

cheap and handy form. It contains all that is required except by students who are engaged in tracing such parts of the development of the mechanical side of surgery as can be shown by the evolution of the instruments employed. Students so working must of necessity use Mr. Doran's catalogue and visit the cases in which the instruments are kept. Sir Arthur Keith, Conservator of the Royal College of Surgeons Museum, says in his Foreword : " It serves not only as a guide to the more important exhibits but also as an introduction to the very interesting principles which underlie surgical inventions. Indeed the book is more than a Guide ; it is an important contribution to the history of Surgery."

The first section deals with surgical instruments, in which the museum is extraordinarily rich. There is a remarkable plate showing the evolution of the scalpel, an instrument which seems to have passed down the ages with very little change. It has always been forged in a single piece of copper, bronze, iron, or steel, according to the metal in use at the time of its manufacture, but the blade has always retained the shape of the curved flint chip used by palæolithic man. A sharper and better edge could undoubtedly have been obtained on a metal instrument, but for ritual purposes the flint knife still holds its own in many circles. It was not until the first quarter of the present century that American ingenuity devised a scalpel with interchangeable blades which could be fitted to a separate handle, but even these blades retain the bow-shaped outline of the original flint flake. To complete the series one of these scalpels should be included in the collection.

The origin and development of the trephine is also amply illustrated. For some unknown reason, or perhaps for many different reasons, the removal of portions of the skull bones has always presented a peculiar fascination for races widely separated ethnologically, and it is still practised by tribes so near Europe as the Berber Arabs. In prehistoric times a scraper of shell, flint, or obsidian was used to remove a circumscribed piece of bone from the dead or the living. Holes were drilled at a later period with an auger or Archimedian drill, the holes being afterwards connected until a crown of bone could be removed. The trephine as it is now known does not seem to have come into use until late in the sixteenth century, its invention being attributed to Fabricius of Aquapendente (1537–1619), whose lectures were attended by Dr. William Harvey. The instrument underwent many slight modifications at the hands of surgeons in all countries until it became standardized in its present form, and, having become so standardized, surgeons returned to the older method recommended by Lanfranc, who died in 1315, when they wished to turn down a flap of bone, and have thus gone back from trephining to trepanning.

The College Museum is rich, too, in bougies and catheters, in lithotomy forceps, gorgets, and lithotrites, as well as in obstetrical and gynæcological instruments. When vesical calculus was common every surgeon in large practice devised some special instrument for its removal. The Museum contains more than fifty of these inventions—some safe and useful, others which must have been dangerous even in the hands of their authors. The development of midwifery forceps can also be followed out very completely from the Chamberlen forceps of 1600 to the axis-traction forceps of 1883. In like manner the evolution of the stethoscope and of the clinical thermometer can be traced step by step, and it can be seen that, although in their inception they were of foreign origin, in their present form they are essentially English.

The fame of Lister as a scientific surgeon has done much to eclipse the reputation which he would have otherwise attained as a skilful inventor. Mr. Thompson has done well, therefore, to give a detailed account of the Lister Collection gathered together and sumptuously housed by the pious efforts of his nephew, the late Sir Rickman J. Godlee. The collection consists of three groups. The first, instruments devised, modified, or freely used by Lister, examples being : an abdominal tourniquet, a sinus forceps, a urethral forceps, a lithotrite, and a bistoury. The second group are instruments used by his father-in-law, James Syme ; whilst the third group is a collection of over forty instruments many of which had already become obsolete when he had them, so that their value is wholly sentimental.

The Historical Room contains a variety of objects of varying interest. There

are chastity belts, and an electrical machine used in the daily practice of John Birch, surgeon to the second troop of Horse Grenadier Guards, as early as 1788 ; whilst on the morbid anatomy side are portions of the intestine believed to have been removed from the body of Napoleon Bonaparte ; a rib of King Robert the Bruce which was fractured in a joust ; the thymus gland of Princess Louise, who died in 1832 ; the root of the aorta of King William IV showing calcification of the valves ; and the hands of Thomas Beaufort, third son of John of Gaunt, who died in 1427. Here, too, may be seen the embalmed body of the young woman from whom John Sheldon, the best anatomist and embalmer of the Hunterian School, contracted syphilis, and the first wife of Martin van Butchell, dentist and friend of John Hunter. She was embalmed by William Hunter and Mr. Cruickshank in 1775. Lastly there are shrunken heads from Ecuador and pieces of skin from Danes flayed for pillaging English churches.

It will thus be seen that Mr. Thomson has described a collection to suit all tastes. His descriptions are so clear that the guide will be useful even to those who are unable to visit the collection itself. The frontispiece is a representation of " An Apothecary's Signboard " in the possession of the College. It is dated 1623 and represents the sturdy owner engaged in his various avocations. More properly it should be labelled " The Signboard of a Barber-surgeon " of the period. Finally, there is an excellent index.

BOOK NOTICES.

[The Editorial Committee acknowledge with thanks the receipt of the following volumes. A selection will be made from these for review, precedence being given to new books and to those having the greatest interest for our readers.]

St. Bartholomew's Hospital Reports. Edited by SIR THOMAS HORDER, Bart., K.C.V.O., RONALD G. CANTI, WILFRED SHAW, W. LANGDON BROWN, W. GIRLING BALL, and GEOFFREY EVANS. Vol. LXII. Demy 8vo. Pp. 262 + xxv, illustrated. 1929. London : John Murray. 21s. net.

Radium Practice, 1929. Edited by ROCK CARLING and the *Westminster Hospital Reports* (Vol. XXI) Editors, STANFORD CADE and DONALD PATERSON. Demy 8vo. Pp. 258 + viii, with 12 illustrations. 1929. London : H. K. Lewis & Co. Ltd. 7s. 6d. net.

Gastric and Duodenal Ulcer. By ARTHUR F. HURST, M.A., M.D. (Oxon.), F.R.C.P., Senior Physician to Guy's Hospital ; and MATTHEW J. STEWART, M.B. (Glasgow), F.R.C.P., Professor of Pathology, University of Leeds. With the co-operation in the Radiological Section of P. J. BRIGGS, M.A. (Cantab.), M.R.C.S., L.R.C.P., Radiologist to New Lodge Clinic and the Medico-Neurological Clinic, Guy's Hospital. Crown 4to. Pp. 544 + xvii, with 159 illustrations and 10 coloured plates. 1929. London : Humphrey Milford. 63s. net.

Die Chirurgie. A System of Surgery. Edited by Professors M. KIRSCHNER (Tübingen) and O. NORDMANN (Berlin). Fasc. 25 (Vol. III). Royal 8vo. Pp. 387–608, with 105 illustrations in the text and 8 coloured plates. 1929. Berlin and Vienna : Urban & Schwarzenberg. RM. 15.

The Treatment of Varicose Veins of the Lower Extremities by Injections. By T. HENRY TELVES-BARKER, M.D., B.Sc. Crown 8vo. Pp. 120, illustrated. 1929. Bristol : John Wright & Sons Ltd. 6s. net.

Westminster Hospital Reports. Edited by STANFORD CADE and DONALD PATERSON. Vol. XX, 1924–1928. Demy 8vo. Pp. 343 + viii, illustrated. 1929. (Published October.) London : H. K. Lewis & Co. Ltd. 7s. 6d. net.

The Injection Treatment of Varicose Veins. By A. H. DOUTHWAITE, M.D., F.R.C.P. (Lond.), Assistant Physician to Guy's Hospital. Fifth edition. Crown 8vo. Pp. 58 – x. 1929. London : H. K. Lewis & Co. Ltd. 4s. net.

Hæmodynamics. The Mechanism of Venous Capillary and Lymphatic Flow ; Œdema ; and Injection Treatment of Varicose Veins. By P. B. KITTEL, F.R.C.S., Assistant Surgical Officer at the Royal Northern Hospital, London. Crown 8vo. Pp. 196 + xi, with 3 plates and other illustrations. 1929. London : H. K. Lewis & Co. Ltd. 10s. net.

The Mobilization of Ankylosed Joints by Arthroplasty. By W. RUSSELL MACAUSLAND, M.D., Surgeon in Chief, Orthopedic Department, Carney Hospital; and ANDREW R. MACAUSLAND, M.D., Orthopædic Surgeon, Carney Hospital, Boston, Mass. Medium 8vo. Pp. 252 + vii, with 154 engravings. 1929. Philadelphia: Lea & Febiger. $4.00 net.

Practical Local Anæsthesia and its Surgical Technique. By ROBERT EMMETT FARR, M.D., F.A.C.S. Minneapolis. Second edition, thoroughly revised. Royal 8vo. Pp. 611 + xxiii, with 268 engravings and 16 plates. 1929. London: Henry Kimpton. 42s. net.

Testicular Grafting from Ape to Man. By SERGE VORONOFF, Director of the Laboratory of Experimental Surgery of the Collège de France, etc.; and GEORGE ALEXANDRESCU, Formerly Assistant at the Institut d'Histologie, Staff Hospital Physician, Bucharest, Roumania. Translated by THEODORE C. MERRILL, M.D. 8vo. Pp. 125 + viii, with 39 illustrations. 1929. London: Brentano's Ltd.

Minor Surgery. By FREDERICK CHRISTOPHER, M.D., F.A.C.S., Associate in Surgery at Northwestern University Medical School. With a Foreword by ALLEN B. KANAVEL, M.D., F.A.C.S., Professor of Surgery, Northwestern University Medical School. Medium 8vo. Pp. 694, illustrated. 1929. Philadelphia and London: W. B. Saunders, Co. 36s. net.

Nouveau Traité de Médecine: Le Cancer. Fasc. V (Vol. II). By GUSTAVE ROUSSY, with the collaboration of ROGER LEROUX and MAURICE WOLF. Second edition, entirely reset. Royal 8vo. Pp. 846, with 284 illustrations and 19 plates of four colours. 1929. Paris: Masson et Cie. Fr. 100.

La Pratique du Pneumothorax thérapeutique et de la Collapsothérapie. By F. DUMANEST and P. BRETTE. Third edition of La Pratique du Pneumothorax théra-peutique by F. DUMAREST and Ch. MURARD. With the collaboration of F. GUILLOT, P. GARCIN, Assistants; J. ANGIRANY, Radiographer at the Sanatorium Felix Mangini, à Hauteville. Preface by Dr. F. BEZANCON. Medium 8vo. Pp. 409 + xiii, illustrated. 1929. Paris: Masson et Cie. Fr. 50.

Chirurgie des Os et des Articulations des Membres. By P. LECÈNE, Professeur à la Faculté de Médecine de Paris; Chirurgien de l'Hôpital Saint Louis. With the collabor-ation of P. HUET, Chirurgien des Hôpitaux de Paris. Pp. 591, illustrated. 1929. Paris: Masson et Cie. Paper covers, Fr. 125; bound, Fr. 140.

Die Wiederbelebung: Eine zusammen-fassende Darstellung ihrer Theorie und Praxis. By Professor Dr. OSKAR BURNS and Dr. KARL THIEL, der Medizinischen Universitäts-Poliklinik, Königsberg. Super Royal 8vo. Pp. 109, with 26 illustrations. 1930. Berlin and Vienna: Urban & Schwarzenberg. RM. 9.

Applied Anatomy. The Construction of the Human Body considered in Relation to its Functions, Diseases and Injuries. By GWILYM G. DAVIS, M.D., Late Professor of Orthopedic Surgery and Associate Professor of Applied Anatomy in the University of Pennsylvania. Revised by GEORGE P. MULLER, M.D., Professor of Clinical Surgery in the University of Pennsylvania. Eighth edition revised. Super Royal 8vo. Pp. 638 + xii, with 656 illustrations mostly from original dissections and many in colour by Edwin F. Faber. 1929. London: J. B. Lippincott Co. 42s. net.

Chirurgie. Teil I: Allgemeine Chirurgie. Revised by Prof. Dr. D. KULENKAMPFF, Zwickau. Sechste mit der fünften übereinstimmende Auflage. (Breitenstein's Rep. Nr. 13a.) Crown 8vo. Pp. 187, illustrated. 1929. Leipzig: Johann Ambrosius Barth. Paper covers, RM. 4.80; bound, RM. 5.60.

Guy's Hospital Reports. Edited by ARTHUR F. HURST, M.D. October, 1929. Vol. LXXIX (Vol. IX Fourth Series). No. 4. Medium 8vo. Pp. 379–500, illustrated. 1929. London: Lancet Ltd. Annual subscription, £2 2s. net, or 12s. 6d. net per issue.

Die diätetische Vor- und Nachkur bei der operativen Behandlung der Lungentuber-kulose. By ADOLF HERMANNSDORFER. Crown 4to. Pp. 18, with 21 plates. 1929. Leipzig: Johann Ambrosius Barth. Paper covers, RM. 2.50.

Anæsthesia and Anæsthetics. By F. S. ROOD, M.B., B.S. (Durham), Anæsthetist to University College Hospital; and H. N. WEBBER, M.A., B.Chir. Cantab., Anæsthetist to University College Hospital. Demy 8vo. Pp. 292 + xi, illustrated. 1930. London: Cassell & Co. Ltd. 14s. net.

Devils, Drugs, and Doctors. The Story of the Science of Healing from Medicine-Man to Doctor. By HOWARD W. HAGGARD, M.D., Associate Professor of Applied Physiology, Yale University. Medium 8vo. Pp. 405 + xxii, illustrated. 1929. London: William Heinemann (Medical Books) Ltd. 21s. net.

To

Sir JOHN BLAND-SUTTON, Baronet,

First President of

the Association of Surgeons of

Great Britain and Ireland

This number of the British Journal of Surgery is dedicated,
on the occasion of the seventy-fifth Anniversary of his Birth
on April 21, 1855

John Bland-Sutton

THE
BRITISH JOURNAL OF SURGERY

EPOCH-MAKING BOOKS IN BRITISH SURGERY.

By Sir D'ARCY POWER, K.B.E., LONDON.

XII. SIR ASTLEY COOPER'S "TREATISE ON DISLOCATIONS AND FRACTURES."

Sir Astley Cooper's *Treatise on Dislocations and Fractures of the Joints* was the English classic until the American surgeons introduced manipulation in place of pulleys and until the whole subject was revolutionized first by the discovery of X rays and afterwards by the enormous experience gained during the European War.

The book, a large quarto illustrated with thirty plates, first appeared in 1822, and is dedicated in a graceful preface to the students of St. Thomas's and Guy's Hospitals. It ran through ten editions and was published at the price of £1 11s. 6d. It is still worth reading, partly for the detailed account of the cases it contains, and partly because it recalls the difficulties which surgeons experienced at a time when anaesthesia was unknown.

The routine preliminary treatment in cases of dislocation of the hip is described in the following words :—

" In the reduction of this dislocation, the following plan is to be adopted ; take from the patient twelve to twenty ounces of blood, or even more if he be a very strong man : and then place him in a warm bath at the heat of 100 and gradually increase it to 110° until he feels faint. During the time he is in the warm bath give him a grain of tartarized antimony every ten minutes until he feels some nausea, then remove him from the bath and put him in blankets and place him between two strong posts about ten feet asunder in which two staples are fixed : or rings may be screwed into the floor and the patient be placed upon it. My usual method is to place him upon a table covered with a thick blanket, upon his back : then a strong girth is passed between his pudendum and thigh and this is fixed to one of the staples. A wetted linen roller is to be tightly applied just above the knee and upon this a leather strap is buckled having two straps with rings at right angles with the circular part. The knee is to be slightly bent but

not quite to a right angle and brought across the other thigh a little above the knee of that limb.   The pulleys are fixed to the other staple and in the straps above the knee.   The patient being thus adjusted the surgeon slightly draws the string of the pulley and when he sees that every part of the bandage is upon the stretch and the patient begins to complain, he waits a little to give the muscles time to fatigue ; he then draws again and when the patient complains much, again rests until the muscles yield.   Thus he gradually proceeds until he finds the head of the bone approach the acetabulum.   When it reaches the lip of the cavity, he gives the pulley to an assistant and desires him to preserve the same state of extension and the surgeon then rotates the knee and foot gently, but not with a violence to excite opposition in the muscles, and in this act the bone slips into place."

What a difference to the simple instruction for reduction after the introduction of anæsthesia—" Put the patient on his back ; flex the leg on the thigh, the thigh on the abdomen ; abduct ; rotate outwards " !

In dislocation of the shoulder Sir Astley recommends reduction by the heel or knee in the axilla, the patient having been previously bled and put into a warm bath at a temperature of 100° or 110°, a grain of tartrate of antimony being given every ten minutes until he becomes faint. " He is wrapped in a blanket, placed in a chair, and extension made before the muscles have time to recover.   The scapula is fixed by means of a bandage which allows the arm to pass through it, a wetted roller is next to be bound around the upper arm just above the elbow, and upon this a very strong worsted tape is to be fastened.   The arm should then be raised at right angles with the body, or a little higher if there be much difficulty of reduction ; two persons should draw the bandage affixed to the arm, and two from the scapula bandage with a steady, equal and combined force. Jerking should be entirely avoided and every quick reduction discountenanced.   " *Slowly and Steadily* " should be the word of command from the surgeon, who after the extension has been made for some minutes should place his knee in the axilla, resting his foot upon the chair ; he then raises his knee by extending his foot ; and placing his right hand upon the acromion pushes it downwards and inwards, when the bone usually slips into its natural position.   A gentle rotatory motion during the extension is sometimes productive of diminished opposition in the muscles.   These means failing we must have recourse to the pulleys—not with a view of employing *greater* force for that could be obtained by more persons ; but with the view of applying *gradual and equal* force without jerks and unequal extension which are sure to occur when manual strength is employed for any length of time."

If Astley Cooper was hampered in his methods partly by tradition but chiefly by the vitality of his patients, he has the credit of putting the etiology of dislocations and fractures upon a sound anatomical basis.   He draws attention to the importance of a knowledge of the ligaments in connection with dislocation, but, dealing only with conscious patients, he attributes the difficulty of reduction almost wholly to muscular contraction.   His teaching in regard to dislocations of long standing was emphatic, for he says :—

" I believe that much mischief is produced by attempts to reduce dislocations of long duration in very muscular persons.   I have seen great contusion

of the integuments, laceration and bruising of the muscles, tension of nerves inducing an insensibility and paralysis of the hand, occasioned by an abortive attempt to reduce a dislocation of the shoulder; so that the patient's condition has been rendered much worse than before. In such cases, even when the bone is replaced, it has often proved rather an evil than a benefit, from the violence of the extension. In those instances in which the bone remains in the axilla, in dislocations of the shoulder a serviceable limb and very extensive motions of it may be regained although reduction has not been effected. I am of opinion that three months after the accident for the shoulder and eight weeks for the hip, may be fixed as the period at which it would be imprudent to make the attempt at reduction, except in persons of extremely relaxed fibre, or of advanced age. At the same time I am fully aware that the shoulder has been reduced at a more distant period than that which I have mentioned; but, in most instances, the reduction has been attended with the results I have just been deprecating. In cases of unreduced dislocation the only course which the surgeon can adopt, after the inflammation which the injury produces has subsided, is to advise motion of the limb and friction of the injured part—the former to produce a new cavity for the head of the bone to assist in forming a new ligament and to restore action to muscles, which they would otherwise lose by repose; the latter, to promote absorption and to remove the swelling and adhesions which the accident has caused."

The plates illustrating the different forms of dislocation and fracture are remarkable specimens of the art of the time, as may be seen in the appended example. The majority were drawn and engraved by C. J. Canton; a few by H. Thompson, and I. T. Wedgwood; some by J. Basire. The unsigned engravings may have been drawn by T. Kirtland who had done much artistic work for Cooper when he published his treatise on hernia. Of Kirtland it is known that he fell into bad ways, could never work without some stimulating beverage at his side, became irregular in the performance of his duties, and had to be discharged. H. Thompson was a poor miniature painter who possessed considerable talent as a draughtsman. He had never studied any of the higher branches of art and consequently was wholly ignorant of anatomy. This was found to be an impediment to him in making the drawings, and Sir Astley Cooper therefore sent him to St. Thomas's Hospital to attend the lectures on anatomy and to engage in practical dissecting. He thus became an efficient artist. He was retained three days a week by Sir Astley and for the remaining three days by Dr. Farre, who was also engaged in the study of anatomy. Thompson afterwards devoted himself to diseases of the eye and did some delicate coloured drawings for Mr. Saunders's book on the subject. They are not so good, however, as those done for Sir Astley Cooper. He ultimately determined to establish himself in some place where diseases of the eye were more frequent than in this country, embarked for the West Indies, and died on the voyage. Sir Astley does not appear to have entered into a regular engagement with any artist after Thompson left him, but employed various draughtsmen like T. Wedgwood and J. Basire until he found C. J. Canton, who proved to be so good that he engaged him permanently after he left Broad Street in the late autumn of 1815 in the

FIG. III.
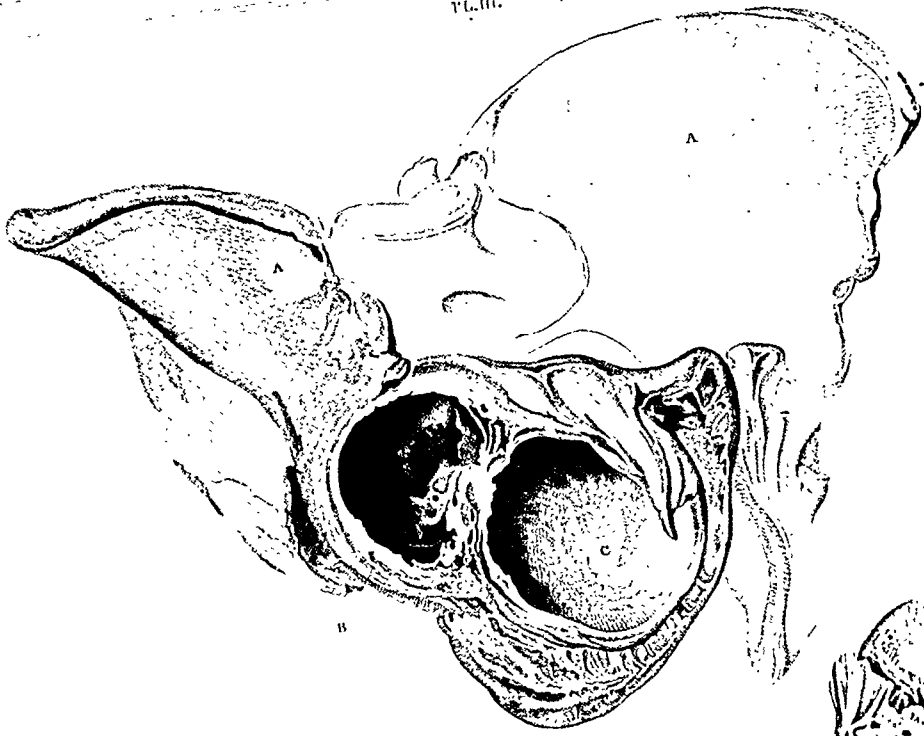
hope of diminishing his practice, which was already too great for his strength.

The illustration is from a preparation in the Museum of St. Thomas's Hospital. It " shows ", says Sir Astley, " a dislocation into the foramen ovale which had never been reduced and beautifully exhibits the resources of nature, in forming a new socket for the head of the bone and allowing of the restoration of a considerable degree of motion ". The relative situation and appearance of the new and original acetabulum are well seen. A, A are the ilia; B is the original acetabulum little more than half its natural size, the edge of the new acetabulum occupying its lower and anterior part; C is the new acetabulum formed in the foramen ovale, a deep ossific edge surrounding it; its internal surface is extremely smooth; the ligament of the foramen ovale has disappeared and ossific matter has been deposited in its stead; D is the thigh bone removed, and the portion of the new acetabulum is shown which was obliged to be broken off to separate the thigh bone from its new socket; E is the head and neck of the thigh bone, the former a little changed by absorption and the latter by ossific deposit.

It does not seem possible now to trace all the ten editions of the book. The first was issued in 1822, the second in 1823, the fifth in 1826, the sixth in 1829, and the tenth in 1839. The octavo edition which was edited by Bransby B. Cooper appeared in 1842.

COMMON-DUCT STONES OF LIVER ORIGIN.

By KENELM H. DIGBY,

PROFESSOR OF SURGERY IN THE UNIVERSITY OF HONG-KONG.

DISEASE amongst the Chinese follows much the same lines as disease amongst Europeans; but there are a number of striking differences. The object of this paper is to draw attention to one of these differences which, so far as I am aware, has not hitherto been described. There is no mention of it in the recently published second edition of Jeffreys and Maxwell's *Diseases of China*.

FIG. 353.—Slices of liver showing intrahepatic stone formation. From a museum specimen. The patient was a Chinese. No clinical history obtainable. (× ⅖.)

When we find a stone in the common bile-duct in a European or American woman it is nearly always of small or moderate size, and we are sure that it originated in the gall-bladder. Large stones in the gall-bladder may ulcerate into the duodenum or transverse colon. Smaller stones may pass along the cystic duct, or occasionally ulcerate into the common duct. Before doing so they have remained in the gall-bladder so long and damaged it to such an extent that this organ has become cicatricially contracted. Hence the well-known generalization of Courvoisier that a distended gall-bladder associated with chronic jaundice is not due to gall-stones. As the gall-bladder is diseased it should always be removed.

In Chinese patients as seen in Hong-Kong we find an entirely different picture. Stones in the common duct usually originate in the liver (*Fig.* 353). When they reach the common duct they grow to a remarkable size (*see Figs.* 356. 358) and lead to distension of the gall-bladder (*Fig.* 354), thus breaking Courvoisier's law. They produce a striking and unmistakable syndrome. Excision of the gall-bladder appears to be contra-indicated.

Though this is the general rule, gall-stones do very occasionally form in the Hong-Kong Chinese gall-bladder, but in my own practice I have operated on many more gall-bladder stones in Europeans than in Chinese, though Europeans number perhaps eleven thousand in Hong-Kong, whilst the natives total almost six hundred and twenty thousand. In addition, Chinese patients from the interior come to Hong-Kong for treatment. Conversely. intrahepatic stone formation occurs as a rarity amongst Europeans. The frequency of its occurrence amongst Chinese in Hong-Kong facilitates the

study of the condition and may perhaps enable some light to be thrown on the relatively uncommon cases in Europe.

It must, however, be confessed that this paper merely opens the subject. One has seen and heard of a large number of cases which one feels confident represent this disorder. I used not at one time to recognize the condition. Some later cases have refused operation; one or two were moribund when first seen. My old friend Dr. G. H. Thomas has seen the affection both at successful operations and at post-mortem examinations, but his notes and specimens (with one exception) were unfortunately thrown away. He first performed an operation for this condition in 1919. This is the earliest case of which I have heard. These cases have regretfully been excluded and I have confined this study to ten cases, seven fully and one partly reported, and all with the diagnosis proved at operation or at post-mortem. Two of the illustrations come from specimens in the museum; they were from mortuary cases where no clinical history was forthcoming. The death-rate is too high, even for this serious class of case, and it seems that one is only now feeling the way to a correct line of treatment.

Etiology.—The sufferers from the condition here reported were all adults (ages 34, 38, 35, 28, 22, 42, 'middle-aged', and 42 years). Four were males, four females. One of these patients was very fat; all the others were spare, and *Case* 2 was very thin. All eight were of the poorer class, but I have seen what appears to be the same condition in well-to-do Chinese. With regard to alcohol, there is no record in *Cases* 1–5 or in *Case* 7. *Case* 6 neither drank nor smoked. *Case* 8 smoked tobacco, but only took small quantities of wine occasionally. *Case* 2 was an opium

FIG. 354.—Portion of liver with distended gall-bladder, cystic, and common ducts. A large stone is seen projecting from the common bile-duct where cut across. From a museum specimen. The patient was a Chinese. No clinical history obtainable. ($\times \frac{2}{3}$.)

smoker and had been sent to prison for keeping an opium divan. None of the patients gave a history of previous illness of any apparent importance.

Morbid Anatomy.—In all these cases there was great enlargement of the common bile and the common hepatic ducts, up to a diameter of one inch (*Case* 6). In every case the gall-bladder was much distended (*Fig.* 354)

and the liver was enlarged. In the post-mortem cases the intrahepatic ducts showed dilatation when the liver was cut across. Adhesions between the liver and great omentum were noted in *Case 6*, and between the liver and diaphragm in *Case 7*. The gall-bladder was recorded as showing adhesions in *Case 6*. In *Cases 1* and *2* the gall-bladder and the bile-ducts contained mucus untinged by bile, signifying that complete suppression of bile had supervened. No stones were found in the gall-bladder of any of these cases, but a little muddy débris was seen in *Case 1*.

In all eight cases, however, stones were found in the common ducts. These appeared to be either very numerous and only moderately large (*Cases 1, 2, 5, 8*), or few in number, one or more, and enormous in size (*Cases 3, 4, 6, 7—see Figs. 356, 358*). These common-duct stones, though definite in shape and often faceted (*see Fig. 356*), were soft enough to be crushed between finger and thumb. When dried the outer laminæ tended to flake off in patches (*see Fig. 358B*). They appeared to consist chiefly of bile pigments. Dr. S. Y. Wong of the Department of Physiology kindly examined parts of the stone removed after death from *Case 7* (*see Fig. 358B*). The results of the analysis were :—

Bilirubin	..	67·30
Biliverdin	..	25·82
Cholesterol	..	1·64
Calcium	..	1·20
Phosphate	..	2·10
Iron	..	trace
Copper	..	trace (?)

Smaller stones were found in the intrahepatic ducts at operation in *Cases 1, 2, 5, and 8*. *Fig. 353* shows the appearance of intrahepatic stones from the post-mortem examination of a patient where no clinical history was obtainable. Such intrahepatic stone formation has been observed by Dr. G. H. Thomas and by myself at other times in the Public Mortuary. The kidneys showed some nephritis.

Pathology.—Infestation of the liver by liver flukes (*Clonorchis sinensis*) is not uncommon in Hong-Kong. I operated on one case of colic due to blockage of the cystic duct by these parasites, and for several days flukes continued to escape in the bile from the fistula. Flukes are not infrequently seen in the liver in post-mortem examinations, and the ova were seen in 21 per cent of 512 cases examined in our medical wards by Dr. Mustapha Bin Osman. They have also been found in association with hypertrophic cirrhosis. Both cirrhosis of the liver and malignant disease of the liver are commoner in South China than in Europe, and the liver fluke has been put forward as a possible explanation. It is natural, then, to suggest that the liver fluke may have something to do with intrahepatic stone formation also ; but our cases give no support to this idea. No flukes were found in our three fatal cases, and repeated examinations for the ova in the fæces were unsuccessful in two others (*Cases 5 and 6*). A single examination of the bile and stone formation ; but a more probable view is that acute cholangitis was also unsuccessful in *Case 1*.

Some chemical food poison might conceivably lead to inspissation of the due to some bacterial infection originates the disease. The rigors and fever

certainly show that acute cholangitis was present in our patients when they came under observation. In *Case* 6 and 8 it was noticed that the bile had a most unpleasant mawkish odour. Direct bacteriological examination of the bile in these cases has not been carried out.

Symptoms and Physical Signs.—Previous attacks of pain in the epigastric and right hypochondriac regions were the rule : in *Case* 1, nine months before ; *Case* 3, five months before ; *Case* 4, " colic two or three years ago " ; *Case* 5, two years ago ; *Case* 6, frequent attacks for four years ; *Case* 8, four or five attacks during the previous six or seven years. These previous attacks were sometimes accompanied by rigors and jaundice.

The present attack had lasted from onset to operation : in *Case* 1, three days ; in *Case* 2, seventeen days ; in *Case* 3, twenty-eight days ; in *Case* 4, seven days ; in *Case* 5, twenty-four days ; in *Case* 6, two and a half months ; in *Case* 7, ? ; in *Case* 8, ten days.

These cases show that there are five cardinal signs or symptoms of this condition. When all five are present the syndrome is so distinctive and so unlike that of other diseases that it may be described as pathognomonic. These five cardinal signs are : (1) Pain in the epigastrium and right hypochondrium ; (2) Enlargement of liver (and of gall-bladder) ; (3) Rigors ; (4) Jaundice ; (5) Albuminuria. These signs were all present in each of our eight cases with few exceptions. In *Case* 7 details are not given as to rigors or albuminuria. The urine was free from albumin in *Cases* 3 and 4, and in *Cases* 4 and 6 irregular fever is recorded but rigors are not mentioned.

1. *Pain.*—The pain was situated in the epigastrium and right hypochondrium. In *Case* 3 pain was also reported in the back. There was no reference of pain to the angle of the scapula or to the acromion process. Sleeplessness as a result of the pain was present in *Case* 3.

2. *Enlargement of Liver and Gall-bladder.*—The liver was enlarged clinically to two, three, or four finger-breadths below the costal margin. The enlarged liver was noted to be tender in *Cases* 1, 2, and 6. Abdominal rigidity especially pronounced on the right side was recorded in *Cases* 2, 5, and 6.

Enlargement of the gall-bladder was always found at operation or at post-mortem, but was sometimes masked at the bedside by the great enlargement of the liver. Clearly seen in *Cases* 2, 4, and 6, it was suspected in *Cases* 3, 5, and 8. When a gall-bladder enlarges it does so downwards and medialwards towards the umbilicus ; but where there is enormous enlargement of the liver as well, the gall-bladder tumour increases directly downwards, and in *Case* 2 presented as a tumour in the right iliac fossa visible through the abdominal wall (*Fig.* 355).

3. *Rigors.*—These were recorded in *Cases* 1, 2, 3, 5, and 8. In *Case* 4 fever only was put down. *Case* 6 showed a typical 'steeple' chart (*see Fig.* 357). Apart from definite rigors, 'chills' were recorded.

A blood-count in *Case* 8 showed a leucocytosis of 20,000 per c.mm. The tongue was coated, and sweating and general weakness were recorded in *Case* 6. Headache was mentioned in *Case* 5, giddiness in *Cases* 1 and 3, and thirst in *Cases* 3 and 8.

4. *Jaundice.*—This was present in all the eight cases, the sclerotics and skin being moderately tinged. Bile pigments were present in the urine as

shown by coloured froth and by a green ring with alcoholic iodine. Skin irritation was noticed only in *Case 2* and was then described as slight. This was the only case in which pale fæces were recorded, but I believe this sign was present in several others. In *Case 1* the motions were recorded as 'feeling hot'.

Loss of appetite is remarked upon in *Cases 1* and *5*, and constipation in *Cases 1, 4,* and *5.* Vomiting or regurgitations were a feature in *Cases 3, 4, 6,* and *8.* In *Case 3* X-ray examination showed gastric stasis. It may here be said that not much use was made of X-ray examinations, as it was felt that the overlapping liver and the bile-pigment composition of the stones were unfavourable. A special technique should perhaps show the shadow of
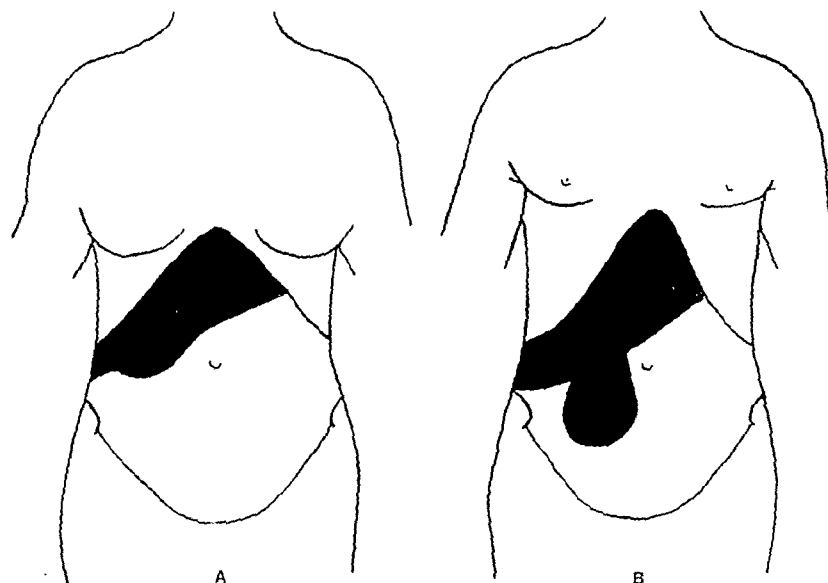
Fig. 355.—A, Diagram of the abdominal tumour usually seen. B. Diagram of the abdominal tumour seen in *Case 2*; both gall-bladder and liver show an unusual degree of enlargement.

the large stones. Graham's tetra-iodo-phenolphthalein gall-bladder concentration test was not tried in this series of cases.

5. *Albuminuria.*—This was the least constant sign of the pentad, being definitely absent in two of the cases. In the others it was present in considerable degree, and casts were found on microscopical examination in *Cases 6* and *8.*

Treatment.—If left alone these cases probably all die from the condition sooner or later. Early operation is therefore indicated; but attacks frequently subside for the time being, and if the general condition is good and the attacks appear to be subsiding, it may be well to wait till jaundice has passed, for reactionary hæmorrhage was a feature in two fatal operation cases. Intramuscular injections of calcium chloride and subcutaneous injections of hæmostatic serum are indicated both before and after operation.

The immediate surgical indication is *choledochostomy with removal of the stones*. The stones causing intermittent obstruction and back-pressure must be taken away; the infected ducts must be freely drained for several weeks.

It is not always possible to remove all the stones. They may stretch up far into the liver. The common hepatic and common bile-ducts are usually large enough in these cases to admit the finger down to the ampulla and up to the bifurcation into right and left hepatic ducts. Stones in the latter may be dislodged with a scoop or by a gentle stream of saline introduced beyond them by a catheter or other tubular instrument. If further small stones are felt far into the liver substance and cannot be dislodged, it would appear to be sound treatment to perform a secondary hepaticodocho-duodenostomy (though I have not yet done this operation for intrahepatic stones). Generally the patients are too ill for this to be attempted at the first operation, but where stones have been left behind in the liver this procedure should be considered some six weeks later. The duodenum is retracted downwards by a stay-stitch after the peritoneum along its upper border has been transversely divided. The dilated common bile-duct is freed and divided. The cut distal end is sewn over, whilst the cut proximal end is implanted into the duodenum. Further stones as they come down will pass harmlessly into the alimentary canal. The biliary system will be freely drained. It will of course be no onger protected by a valve, but this does not seem to matter when hepaticodochoduodenostomy has been performed for stricture of the common bile-duct.

A case of mine in which hepaticodochoduodenostomy for stricture was performed is now extremely fit and well nearly five years afterwards—and this is of course the usual experience. The question arises whether the gall-bladder should be removed or drained. As it does not contain calculi and as it serves as a 'safety-valve' reservoir, delaying and often preventing the onset of complete suppression of bile, removal should not be undertaken. Simple drainage is not always called for, though, at the operation, aspiration of a huge gall-bladder may give better access to the deeper parts.

Approach to the common ducts may be obtained by the usual incisions. The one we now prefer is the right paramedian, and two special points are made : (1) The incision reaches just below the umbilicus so that the tendinous inscription from the umbilicus is divided ; (2) The rectus muscle is infiltrated with several ounces of 0·2 per cent β-eucaine (benzylamine lactate) till it becomes completely flabby. These two measures obviate the need for division or forcible retraction of the rectus muscle later when the spine is hyper-extended in the 'gall-bladder position'. Besides a rubber tube in the common duct for several days, the half of a longitudinally bisected rubber tube is left for twenty-four hours in the right posterior subphrenic pouch.

Mann, of the Mayo Clinic, showed that dogs would survive the two-stage removal of the liver for several weeks if freely supplied with glucose, but would die in forty-eight hours otherwise. Glucose is clearly indicated both as a pre- and post-operative measure for these cases of intrahepatic stone-formation with greatly impaired liver function.

CASE REPORTS.

Case 1.*—Intrahepatic stone-formation; complete suppression of bile: chole-cystostomy and choledochostomy with removal of stones. Recovery.*

Chan How, male, age 34 years, a basket-maker, was admitted to the Civil Hospital on April 21, 1924, with an attack of severe abdominal pain.

HISTORY.—There was a history of a previous attack of abdominal pain which took place nine months ago. The pain was of sudden onset, was chiefly noticed in the right hypochondriac region, and lasted for two days, during which period the appetite was poor and the motions were black and soft. The present attack was ushered in by a chill three days before admission. For a whole fortnight, however, there had been constipation—one action of the bowels in about five days. The chill was followed by fever and pain all over the abdomen, especially in the right subcostal region. The patient felt dizzy and his motions were soft and black and felt hot during evacuation. The appetite was bad. The temperature was 101·2°. A moderate degree of jaundice was present and the urine contained both bile and albumin.

ON EXAMINATION.—An examination of the abdomen showed that a large tumour with a suggestion of lobulation on the surface reached below the costal margin. It was dull to percussion, the dullness being continuous with that of the liver above the costal margin. The lower border of the tumour was thickened and ran obliquely downwards and to the right. It moved slightly on respiration and reached a point just below the umbilicus. The tumour was tender and painful. The greatly enlarged liver with fever would have suggested amœbic abscess ; but jaundice is very unusual in such cases. Some calculus obstruction of the common duct seemed more probable.

OPERATION.—On the day of admission laparotomy was performed through a right paramedian incision. The gall-bladder was found to be distended, and on incision clear glycerin-like fluid with a little black débris escaped. Cholecystostomy was performed. On further examination a large stone was felt projecting from within the liver into one of the hepatic ducts. This lay at a great depth ; it was cut down upon, and removed with difficulty as it was tightly impacted. A further large calculus which was slightly movable was removed from deeply within the liver. Clear glycerin-like 'white bile' escaped from the ducts. Further stones could be felt within the liver, but could not be extracted. A second large rubber tube was inserted into the duct. The laparotomy wound was closed in the usual way. Coloured bile was discovered passing from both tubes by the following morning. The patient was treated after operation with injections of calcium chloride and with rectal glucose and with hypodermic injections of morphia.

On April 26, the patient was again carried to the operation theatre, but no anæsthetic was administered. A long spoon was inserted along the track of the drainage tube into the hepatic ducts and at least a dozen small calculi were removed from the bile-ducts in the liver. They were of solid black matter, oval in shape, and about the size of peas. Some of the discharging bile was examined for *Clonorchis* ova on one occasion, but none were found.

The patient was discharged on May 17 ; the wound was healed ; the fæces were normal in colour ; there was no jaundice, and the temperature had been *normal* since the fourth day after operation.

Case 2.*—Intrahepatic stone-formation; complete suppression of bile; partial cholecystectomy and choledochostomy with removal of stones; reactionary hæmor-rhage. Death on the tenth day.*

Ho Shan, male, age 38 years, committed to prison on a charge of keeping an opium divan, himself an opium smoker. Routine examination by the Prison Medical Officer showed signs of jaundice, and he was transferred to the Government Civil Hospital on May 22, 1924.

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* Previously reported in collaboration with Dr. A. G. M. Severn in the *Caduceus*, 1924, Oct., 145.

HISTORY.—No previous history of attacks of acute abdominal pain or other serious illness was elicited. The patient had noticed the jaundice gradually coming on for some few weeks, but had not regarded it as anything serious.

ON ADMISSION.—On entering the Civil Hospital the general condition was not good, the patient being rather thin and poorly nourished; temperature 99·4°. He complained of some abdominal pain. There was a moderate degree of jaundice, yellow sclerotics, and slight skin irritation. Tenderness and rigidity over the gall-bladder area was present and the liver dullness extended below the costal margin. No other abdominal signs were noted and the gall-bladder was said then to be not definitely palpable (?). The urine contained bile pigment, bile salts, and a trace of albumin; the fæces were rather pale, but not clay-like.

On the day following admission the patient had a rigor, but the temperature did not rise above 101·1°. During the subsequent fortnight the temperature approached normal, generally varying between 98° and 99°. The patient was kept under observation and on light diet and fluids; the jaundice remained about the same; the bowels were regular. Tenderness in the right hypochondrium persisted, with slight rigidity, but without much pain. Salines with ipecacuanha wine and sodium salicylate were given four-hourly. On the seventeenth day the patient had a severe attack of acute abdominal pain, temperature 99°, for which morphia was given. On the following day the temperature rose to 101°. There was marked tenderness and rigidity over the liver area and right hypochondrium. A large mass, dull on percussion, extended down to the right iliac region, producing a tumour readily visible on respiration. The mass was diagnosed as a greatly enlarged gall-bladder (see Fig. 355B).

OPERATION.—The patient was given intramuscular injections of calcium chloride gr. ij, three doses at suitable intervals, in preparation for operation. Hypodermic injections of morphia and atropine preceded the anæsthetic, which consisted of ether only, by the closed method. On June 8 an operation was performed which consisted in an exploratory laparotomy, partial cholecystectomy, and choledochotomy. Hæmorrhage from the small vessels was profuse. The free incision disclosed an enormously distended liver—making approach to the bile-ducts extremely difficult—and a very large, tense, and distended gall-bladder, containing a quantity of 'white bile' which had the appearance and consistency of slightly diluted glycerin, together with a considerable residue of dark-coloured granular débris. An incision was then made into the bile-duct above the cystic duct and close to the liver. Masses of soft friable gall-stones, partially faceted, blocked the bile and hepatic ducts, and extended through the branches of the hepatic duct deep into the liver substance. A number of large gall-stones and fragments were extracted, as far up as three inches into the liver, so that the jam seemed relieved and the remaining stones were freely movable. Their complete removal was a matter of impossibility. The common bile-duct, as far as its junction with the duodenum, appeared to be patent and unobstructed. The fundus of the gall-bladder, having been pulled forward by a clamp to give better access to the bile-duct, was amputated, and a medium-sized rubber drainage tube sutured to the stump. The distended bile-duct was drained with a half-inch diameter tube and a third smaller drainage tube was inserted into the right posterior subphrenic pouch. The poor physical condition of the patient did not admit of a more extensive operation. Normal green bile, in small quantity, commenced to flow, via the drainage tubes, within a few hours of the operation, together with granular débris and small fragments of gall-stones.

After-treatment consisted of normal saline, water, and solution of sodium bicarbonate, in quantities of half a pint, given rectally two-hourly in succession for the first day, and afterwards four-hourly. An attempt was made to obtain glucose for rectal administration, but unfortunately there was none available at the moment in the Colony. Nothing was given for the first twenty-four hours; afterwards fluids at short intervals and in increasing quantities. On the day following the operation the patient had persistent vomiting, which was relieved by a suitable carminative mixture. Tincture of opium in small doses was regularly given, in view of the patient's opium habit. The temperature ranged between 101° and 103°.

Three days after the operation some blood-clot was passed via the drainage tubes, and the bile which escaped was intimately mixed with blood. This continued in spite of hypodermic injections of morphia and intramuscular injections of calcium chloride. The general condition was fair, and the temperature gradually decreased, but the jaundice persisted, a slight improvement only being noticeable in this respect. The temperature remained about 100°, and there were no signs of general peritonitis. After removal of the drainage tubes, a good deal of blood-clot was discharged through the abdominal wound, together with blood-stained bile. The patient became progressively weaker, and death took place on the tenth day after the operation, i.e., on June 18, 1924.

POST-MORTEM EXAMINATION.—Autopsy showed some enlargement of the liver, which was pale and mottled in appearance. Masses of friable stones blocked the main hepatic ducts and extended into the smaller branches, so that the liver appeared to be full of these soft stones. Specimens of them were sent to the analyst for chemical examination. Two separate portions of the liver substance and a piece of the kidney were sent to the pathologist for section. Unfortunately in a considerable rush of work at the time, these were mislaid. A mass of blood-clot was found in the remains of the gall-bladder and in the peritoneal cavity on the right side, extending as far as the right iliac fossa. The common bile-duct was not obstructed, and its opening into the duodenum was normal in appearance. The kidneys were rather pale and slightly enlarged, the capsule separated readily. There were signs of local inflammation of the peritoneum, but no evidence of general peritonitis. The brain and meninges were normal in appearance, as were also the heart, lungs, spleen, pancreas, and alimentary tract.

Case 3.—Two large common-duct stones of liver origin: choledochostomy with removal of stones. Recovery.

Li Tang (Case No. 496/26), female, age 35 years, housewife, was admitted on Dec. 21, 1926, for pain in the upper part of the abdomen and in the back.

HISTORY.—The patient was a married woman with three healthy children. She had always enjoyed good health till five months before, when she had an attack of pain over the right hypochondrium. She went to see a doctor, who gave her one injection, and the pain was then relieved. Two weeks later pain began over the back and then extended to both hypochondriac regions and the epigastrium. Injections gave her temporary relief, but one week later the pain recurred. The pain was accompanied by vomiting and a feeling of chillness in both hands and feet. Sleeping was also disturbed by the pain. Sometimes one or two hours after one of the injections there was giddiness, and the patient felt thirsty for two or three hours.

ON ADMISSION.—When admitted the patient showed no fever, but she complained of pain over the back and slightly over the epigastrium. She was wasted and slightly jaundiced, showing tinting of the conjunctivæ. Bile was present in the urine, but albumin was not found in this case. The blood-pressure was low: systolic 70 mm. and diastolic 40 mm. X-ray examinations showed delayed emptying of the stomach, " a moderate gastric residuum being present after six hours ". I have a distinct recollection that the liver and gall-bladder were clinically enlarged, but there is no note in the report to this effect.

OPERATION.—After two intramuscular injections of calcium chloride (gr. ij each) on Dec. 28 and 29, the patient was subjected to operation, under open warm ether, during which two pints of normal saline were given intravenously. The abdomen was opened by a right paramedian incision. The first part of the duodenum was displaced downwards with a stay stitch and the peritoneum transversely incised along its upper border. A greatly enlarged common bile-duct was thus exposed, and opened by a vertical incision over an inch in length. Bile flowed out, and two gall-stones were removed, which when placed with their flat surfaces together resembled an egg measuring 1½ by 2½ in. (*Fig. 356*). The enormously enlarged duct was explored upwards and downwards with the finger, but no other stones were found. A large rubber tube was introduced into the common duct and lightly secured by a plain catgut purse-string suture.

After operation digitalin injections were given, and glucose (3 per cent) and sodium bicarbonate (1 per cent) were administered per rectum, 6 pints in the twenty-four hours. The rubber tube was removed three days after the operation.

The patient was discharged on Feb. 7, the wound being completely healed. No more pain had been felt in the back or epigastrium, and there had been no more jaundice.

FIG. 356.—*Case* 3. Photograph of two stones removed at operation. (*Actual size.*)

Case 4.—Common-duct stones of liver origin: cholecystostomy and choledo-chostomy with removal of four large stones. Recovery.

Chung Ying Er (Case No. 85/27), female, age 28 years, unmarried, maidservant, 'from up country', was admitted on March 8, 1927, for pain in the epigastrium.

HISTORY.—The patient had suffered from colic two or three years ago, but except for this and for some irregularity of menstruation she had enjoyed good health till the present attack, which began one week prior to admission.

ON ADMISSION.—The temperature was 101·6° and the pulse 104. The patient was very restless and vomited after taking anything by the mouth. Her bowels had not acted for three days, though they usually acted every day. Pain was localized in a circular area of 5 in. diameter, the centre of the circle lying about 1½ in. below and to the right of the xiphoid process. A tumour could be felt below the right costal margin, which was thought to be an enlarged gall-bladder with enlarged liver. Bile pigments were present in the urine, but albumin was not found.

OPERATION.—The patient was taken to the theatre on admission and open warmed ether administered. The abdomen was opened through a right paramedian incision. The liver was seen to be enlarged and congested and the gall-bladder was also enlarged. The latter was opened and bile escaped, but no stones were found. A rubber tube was inserted into the gall-bladder and retained by a purse-string suture. The common duct was then exposed and incised and a round-worm seven inches long removed. On further investigation four stones were removed from the duct. The largest of these measured 1 in. by ¾ in. by 1¼ in. The common duct was drained by rubber tubing. One and a half pints of intravenous saline were administered during the operation.

All drainage tubes were removed on the sixth day. Thirty-seven days after operation the patient left hospital, free from jaundice and pain and with her wound healed.

Case 5.—Intrahepatic stone-formation: choledochostomy with removal of small stones. Death on the ninth day.

Ip Kam (Case No. 113/27), male, age 22 years, unemployed, was admitted to the medical wards with severe epigastric pain on March 7, 1927.

HISTORY.—Previous illnesses were small-pox at the age of 3 years, measles at the age of 4 years, and chancre at the age of 20. Two years ago he had also had a

severe attack of epigastric pain similar to the present one. His present attack began eight days before, with epigastric pain, shortly followed by a rigor and fever. The fever abated but the pain persisted, and the next day rigor and fever recurred in the afternoon. There was also some headache. The pain continued ; it was not accompanied by vomiting. There was no constipation, but the appetite was poor.

ON ADMISSION.—It was seen that patient was jaundiced ; bile was present in the urine, as also was albumin. Pain was felt in the epigastrium. The abdominal wall was rigid. The liver was enlarged three finger-breadths below the costal margin on the right side and two finger-breadths on the left side. The spleen was not palpable. The fæces were pale and clay-coloured. On microscopic examination no ova were found. The temperature was 103·8° and the pulse 112. A blood smear was taken ; no malarial parasites were seen. The temperature fell next day and kept normal till March 12, when the patient insisted on going out. The pain had gone, but bile and albumin persisted in the urine. The next day abdominal discomfort was again felt, the appetite was poor, and the bowels did not act. Later in the day epigastric pain set in with headache, rigor, and fever. On the 14th headache, rigor, and fever recurred. On the 15th the epigastric pain was worse and the fever increased.

On March 16 the patient was readmitted to the medical wards with a temperature of 101° and a pulse of 104. The jaundice was deeper, and bile and albumin (0·05 per cent) were present in the urine. The liver was now enlarged to three finger-breadths below both costal margins. Emetine injections were given. On the night of the 18th the temperature reached 105° ; on the evening of the 20th there was a rigor and the temperature reached 105·8°. The temperature was normal on the 21st and 22nd. A blood-count on the 19th showed a leucocytosis of 14,300, with 94 per cent polymorphonuclears. An examination of the fæces showed the presence of adult Trichuris trichiura, but no ova of any kind.

OPERATION.—On March 22, the patient was transferred to the surgical wards, and on the following morning under open warm ether the abdomen was opened through a right paramedian incision. The gall-bladder was only slightly enlarged. but there were some adhesions to the neck. The enlarged common bile-duct was opened, bile escaped, and two minute stones were removed and more were felt high up in the liver but could not be extracted. One and a half pints of glucose (3 per cent) and sodium bicarbonate (1 per cent) were introduced by a catheter along the common duct into the duodenum. A large drainage tube was secured in the common duct and another tube placed in the right posterior subphrenic pouch. Four days later the large tube came out by itself.

The case did not do well after operation. Fever continued and the pulse gradually rose in spite of injections of digitalin. Death occurred nine days after operation, on April 1, 1927. Post-mortem examination was performed but the notes have been mislaid.

Case 6.—Enormous common-duct stone of liver origin: choledochostomy with removal of stone. Recovery.

Lo Sze (Case No. 85/29), female, age 42 years, was admitted to the Civil Hospital on March 14, 1929, for pain in the epigastrium and right hypochondrium. She had been married at the age of 18 and had had three children, all then living and healthy. Her husband was alive and well. She neither drank nor smoked.

HISTORY.—Four years ago the patient had begun to suffer from frequent attacks of pain in the epigastrium and right hypochondrium. During each attack there was stabbing pain which was accompanied by vomiting, rigor, fever, headache, sweating, and general weakness. Each attack of pain lasted for a few hours and occurred two or three times a month. Chinese medicines had been taken and plasters applied without relief. For the last two months before admission the pain was much more severe and so frequent as to be almost continuous.

ON ADMISSION.—The patient complained of stabbing pain in the epigastrium and right hypochondrium. There was rigidity of the abdomen and tenderness

below the costal margin. The liver was enlarged and the gall-bladder apparently also enlarged. The tongue was thickly coated, the temperature 103·4°. Jaundice could be seen in the conjunctivæ and in the skin of the anterior abdominal wall. The urine contained bile-pigment, albumin, and epithelial casts. The patient was kept under observation till April 3. The Wassermann test was negative. The stools were examined on three separate occasions, but no *Clonorchis* ova were found. During this period the jaundice subsided and the general condition improved. On the night of April 26 a sharp 'steeple' rise of temperature occurred (*Fig.* 357). A diagnosis of common-duct stones of liver origin was made.
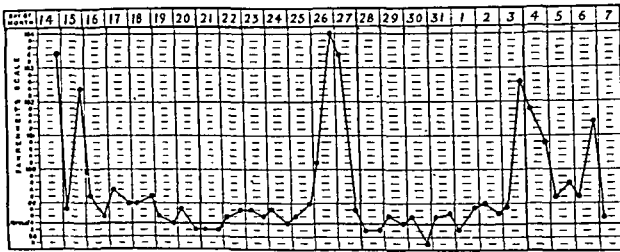
Fig. 357.—*Case* 6. Portion of temperature chart showing a 'steeple' rise in an apyrexial period.

OPERATION.—On April 3, the abdomen was explored through a right paramedian incision. The liver and gall-bladder were both enlarged and the greater omentum was adherent to both. These adhesions were divided and disclosed an enormous common duct. A longitudinal incision 1½ in. long was made into the duct and a sausage-shaped stone 2¾ in. by 1 in. was removed (*Fig.* 358, A). Bile flowed freely. No other stones were detected. A large tube was placed in the

A   B

Fig. 358.—A, *Case* 6. A large stone removed at operation from the common bile-duct. The patient recovered. B, *Case* 7. A stone removed post mortem. The patient had refused operation. (× ⅗.)

common duct and a small drain in the right posterior subphrenic pouch. The pulse was very small and quick for forty-eight hours, but thereafter the convalescence was rapid. Bile of unpleasant odour continued to escape till the fifth day, when it suddenly stopped.

When discharged on April 28, the patient felt fit and well, the wound was soundly healed, there was no abdominal pain, the urine was free from bile and albumin, and no ova were present in the stools.

Case 7.—Common-duct stone of liver origin: no operation. Death.

A middle-aged Chinese man was admitted with jaundice and abdominal pain under the care of Dr. G. H. Thomas in 1928. Dr. Thomas, who has successfully operated on several of these cases (all in middle-aged men), advised operation. The patient obstinately refused surgical intervention and died about ten days after admission. At a limited post-mortem examination the stone showed in *Fig.* 358, B was removed.

Case 8.—Intrahepatic stone-formation: choledochostomy with removal of a few small stones: some hæmorrhage. Death in four hours.

Chou Sing (Case No. 300/29), female, age 42 years, was admitted to the Medical Unit in the Government Civil Hospital under the care of Dr. T. Y. Li on June 1, 1929.

HISTORY.—The patient was a well-nourished fat-looking woman. She habitually smoked tobacco, but only took small quantities of wine occasionally. She had married at the age of 22 and had had two children who died in infancy, and she then lost her husband. She had been constipated for a long time, and had suffered from bouts of abdominal pain on four or five occasions during the previous six or seven years. For the year before admission she had suffered from frequent attacks of palpitation of the heart. There was no history of dysentery.

The present illness began a week before admission with the onset of epigastric pain after a meal of vegetables. The pain was soon followed by nausea, and after one day by frequent eructations and regurgitation of sour fluid, but no vomiting. The pain was continuous and was increased by moving or rolling to either side. For the last three days the bowels had not acted and the abdominal pain had increased, with tenderness and distension of the abdomen. Though the pain was epigastric it had radiated to the right hypochondrium, and there was more tenderness in the right upper part of the abdomen than on the left side. There was no pain referred to the right shoulder. Appetite was poor, but there was much thirst. There was no headache.

Shortly after admission the patient experienced a rigor, the temperature shooting up to 104°. The tongue was dry, the teeth were dirty, and the gums showed pyorrhœa. No malaria parasites were seen on blood examination, and there was a leucocytosis of 22,000 per c.mm.

The liver was enlarged several finger-breadths below the costal margin ; it was clinically uncertain whether an enlargement of the gall-bladder could also be distinguished. Slight jaundice was present and bile pigments were found in the urine. The urine further showed a large amount of albumin. Casts and pus cells were also reported. The pulse kept over 100 per minute and there was some cyanosis. The first heart-sound was very much accentuated, the spacing short, and the second sound hardly audible. The heart was not enlarged and there were no murmurs. No ova were found in the fæces except those of *Oxyuris vermicularis*.

OPERATION.—On June 3 the patient was transferred to the Surgical Unit and prepared for operation by rectal injections of glucose and intramuscular injections of calcium chloride. Under local anæsthesia (intercostal nerve-block, the lower six intercostal nerves below the costochondral junctions being infiltrated with a total of 20 c.c. of 1 per cent novocain solution*) an upper right paramedian laparotomy was performed. Blood was at once seen in the abdominal cavity and this was later found to be due to accidental pricking of the liver during the intercostal nerve-block, which had been rendered difficult by the fatness of the patient. Owing to the patient's straining on manual exploration, a little warmed ether was then given.

The gall-bladder was greatly enlarged ; the liver was also enlarged and adherent to the diaphragm. The common duct appeared to be increased in size, but it was only with great difficulty that a few small stones were detected, one at the ampulla and the others close up to the liver. The patient's pulse was 140 per minute and very weak. One and a quarter pints of 2 per cent sodium chloride were administered intravenously. The duodenum was displaced downwards, the common duct opened, and several soft small elongated stones were extracted. A rubber tube was left in the common duct and a half tube in the right posterior subphrenic pouch. The rest of the wound was closed. When the duct was opened large quantities of bile flowed out and the sickening mawkish smell was very pronounced. Unfortunately no swab was taken for bacteriological examination.

After operation the patient kept struggling to get out of bed. The colour of

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* One hundred c.c. of 0·2 per cent β-eucaine solution were also used locally in the abdominal wall.

the finger-nails and lips remained a good red, but she died four hours after the operation.

POST-MORTEM EXAMINATION.—A clot representing perhaps half a pint of blood was found between the liver and the diaphragm, which were more or less united by old adhesions along the anterior margin of the liver. The gall-bladder and common ducts were enlarged and friable. The hepatic ducts were dilated and filled with inspissated bile. No actual calculi were present. The heart was very fatty and the aorta showed patches of atheroma. Pieces of the gall-bladder, liver, and kidney were sent for microscopical examination. All showed inflammation, but post-mortem changes prevented clear pictures.

DUODENAL DIVERTICULOSIS.

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DURING the last fifteen months I have found two instances of duodenal diverticulosis in the dissecting-room of the Department of Human Anatomy in the University of Oxford.

First Specimen.—This was found in the body of a woman, age 63. The duodenum here shows five pouches, all in its second, third, and fourth parts, which are arranged as follows :—

Diverticulum 1.—The most proximal pouch (*Fig.* 359, 1) is 6·5 cm. from the pylorus and 4 cm. from the biliary papilla and springs from the antero-medial aspect of the bowel. It measures 2 cm. in depth and has a wide opening. There was no sign of this pouch externally ; its orifice was found when the duodenum was opened, and its fundus was then dissected out from the head of the pancreas, in which it lay much nearer the ventral than the dorsal surface.

Diverticula 2 *and* 3.— These pouches are paired and peri-Vaterine (*Fig.* 360, 2, 3). They arise on either side of the major papilla and the same plica circularis arches over all three structures (*Fig.* 361).

Diverticulum 2, the left or medial one, is 5 cm. in depth. with a bottle neck and a comparatively small opening into the bowel. The fundus
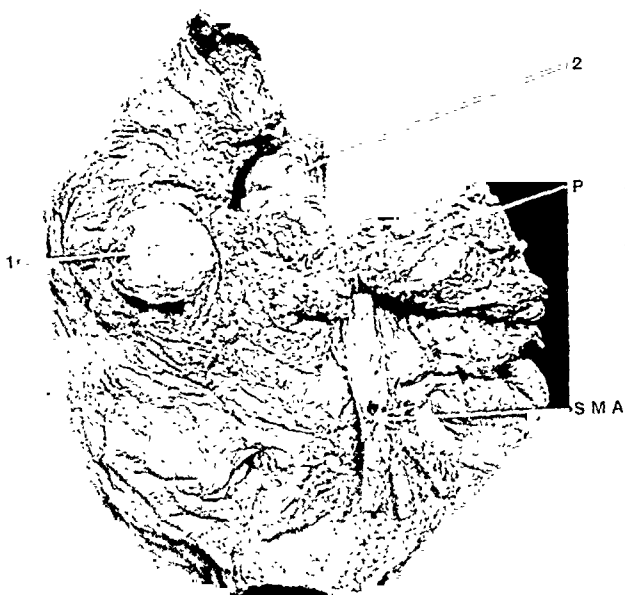
FIG. 359.—The duodenum and pancreas from in front, showing *Diverticulum* 1 (1); the fundus of *Diverticulum* 2 (2) is seen projecting behind the upper border of the head of the pancreas. S M A, Superior mesenteric artery : P, Pancreas.

lay in the head of the pancreas and immediately to the left of. and ventral to, the common bile-duct. The duct of Wirsung winds round the dorsal side of its neck.

Diverticulum 3, the right or lateral one, is 4 cm. deep and has the smallest orifice of any except *Diverticulum* 5. It lay dorsal to the descending duodenum and immediately lateral to the common bile-duct. This was the

only one of these diverticula that showed externally: its fellow was discovered by the dissector as he traced out the bile and pancreatic ducts.

Diverticulum 4.—The fourth pouch was found along the upper border of the third division of the duodenum, 5 cm. distal to the biliary papilla. It is rather cauliflower in shape, 3 cm. deep and 4 cm. across at its widest part. Its constricted neck has an orifice about the size of a threepenny bit. Its fundus was also dorsal to the head of the pancreas, which was here so atrophied, as a result of its pressure, that only a fairly thick fibrous layer separates the diverticulum from the superior mesenteric vessels.

Diverticulum 5.—The last pouch occurred at the junction of the third and fourth parts of the

FIG. 360.—The duodenum and pancreas from behind. 2, 3, 4, and 5 mark diverticula. C B D, Common bile-duct; W D, Wirsung's duct; P, Pancreas.

FIG. 361. The duodenum laid open to show the orifices of *Diverticula* 1, 2, and 3 into the bowel: a glass rod is seen projecting from the orifice of Vater's ampulla.

duodenum, 4·5 cm. distal to the last, to which it is similar in every way except in its size. It is only 1·5 cm. in depth. Neither of these latter pouches was found until their openings were noticed after the bowel was laid open.

All these diverticula were found empty—they appear in my figures lightly distended with cotton-wool—and are alike in that they have very thin walls, which appear to consist of mucous membrane only, while the muscular coat stops short at their neck, round which it forms a sort of sphincter. This is best shown in *Diverticula* 4 and 5.

MICROSCOPIC EXAMINATION OF THE WALL OF THE DIVERTICULUM.—A strip was removed to include the duodenal wall and the proximal portion of

a pouch, and this showed : (1) An abrupt cessation of both muscle coats ; (2) The pouch wall composed of mucous membrane, muscularis mucosæ, submucosa, and an adventitia ; (3) Lieberkühn's crypts become shallower and villi fewer and shorter as the section is traced towards the fundus. In one place, near the apex of the strip, the mucous membrane appears to recover itself partially, but for the most part it is atrophied. One group of Brunner's glands is seen in the wall of the neck of the sac, but none elsewhere.

Apart from the presence of these pouches, the duodenum appears to be normal. There is no evidence of any obstruction at the duodenojejunal flexure, nor was any other abnormality found elsewhere in the abdomen, and the diverticula apparently gave rise to no symptoms during life.

Fig. 362.—The transverse and ascending portions of the duodenum with a portion of the head of the pancreas, which has been held apart from the bowel to show the relation between the diverticula and the vessels entering the duodenal wall.

Second Specimen.—The second specimen (*Fig.* 362) came from the body of a man, age 71. Here the two diverticula are very small and arise along the upper border of the termination of the transverse and the commencement of the ascending portion of the duodenum. Both of them, when found, were empty shrivelled sacs, situated between the duodenum and the head of the pancreas, ventral to and uncovered by the latter.

The smaller of these two pouches was removed for section, and this shows exactly the same condition microscopically as in my first specimen, except that in this case the mucous membrane is much more atrophied. No other pouches were found elsewhere in the intestine, and the only other abnormality in the abdomen was a bilateral reduplication of the ureter. As would be expected, the patient never had any symptoms that could be associated with these small diverticula. The medical superintendent of the mental hospital where he died kindly informed me that he had cystitis due to an enlarged prostate, and " towards the end, a toxic jaundice ".

HISTORICAL.

Chomel is always credited with the first description (1710) of a diverticulum arising from the duodenum, but this may well have been a dilatation of Vater's ampulla, as it contained twenty-two biliary calculi. Morgagni in 1761, Rahn in 1796, and Fleischmann in 1815, all described cases found post mortem ; the two former each found a single diverticulum in the first part of the duodenum, the latter published three cases of multiple pouches in the second portion.

The first English record is by Harley in 1857, who found, in an old man, a diverticulum half way between the pylorus and Vater's papilla containing a large calculus. Probably, as there were adhesions at the fundus of this sac, it was rather a traction pouch, into which the stone had ulcerated. Here, too, must be mentioned Perry and Shaw's article on " Diseases of the Duodenum " in the *Guy's Hospital Reports* of 1893, in which is to be found the first critical analysis of a number of cases of this deformity, based on the Guy's post-mortem records.

Up to 1908 less than a hundred cases of diverticulosis had been recorded, and these were regarded rather as anatomical or, perhaps, pathological curiosities. In this year Rosenthal published the case of a woman, age 70, who, after suffering from a bad heart and kidneys for some years, developed jaundice and died. The autopsy showed an inflamed diverticulum, the size of a walnut, close to Vater's ampulla, dilatation of the bile-ducts, and punctiform areas of fat necrosis in the pancreas. Rosenthal considered that the diverticulum had compressed the terminal portions of both the common bile-duct and the duct of Wirsung. Again, in 1912, Bauer recorded the case of a man, age 52, on whom a gastrojejunostomy was performed for persistent vomiting. He died a few days later of pneumonia, and the only cause found post mortem for his vomiting was the larger of two diverticula, which arose from the posterior wall of the duodenum near Vater's papilla and, being 5 cm. long, had compressed the bowel above it. These two cases may be considered 'classical', as being the first recorded instances of these diverticula being responsible for the deaths of their owners, while Bauer's marks the first occasion on which an operation was performed (although unknowingly) for their relief.

In 1913 J. T. Case was the first to publish an instance of diverticulosis diagnosed during life by means of the X rays and the opaque meal. This great advance was followed in 1915 by Forsell and Key's success : a diverticulum was correctly diagnosed by X rays and then removed by operation.

FREQUENCY OF DIVERTICULOSIS.

In an attempt to form a correct estimate of the frequency of this abnormality, one is met by a variety of different percentages, depending primarily on two factors, the age of the individuals examined and the care with which the search for them is conducted. It is not surprising that dissecting-room figures are high when one remembers that most of the subjects are very aged people. Thus, J. C. B. Grant for a period injected with paraffin all duodena that came into the dissecting-room, and then found diverticula in 6 out

of 37 (16 per cent). Such a high figure is only almost equalled by Baldwin. *Table I* shows the frequency of all types of diverticula found post mortem.

Table I.—PERCENTAGE OF ALL TYPES OF DIVERTICULA FOUND POST MORTEM.

AUTHOR	POST-MORTEMS	CASES OF DIVERTICULOSIS	PERCENTAGE
Linsmayer	1367	45	3·3
Baldwin	105	15	14·2
Grant	37	6	16·0

Table II shows another series of figures published by different radiologists, who are, of course, dealing with patients with some gastro-intestinal symptoms. Comparing the figures given by these five authors, we get 2·5 per cent as an average for the incidence of diverticulosis diagnosed in X-ray examinations. This agrees, perhaps only roughly, with Linsmayer's 3·3 per cent from post-mortem records. Grant's much higher percentage from the dissecting-room would seem to indicate, as Maclean suggests, that the X rays

Table II.—PERCENTAGE FREQUENCY OF DIVERTICULOSIS FOUND BY THE X RAYS.

AUTHOR	CASES EXAMINED	CASES DIAGNOSED AS DIVERTICULOSIS	PERCENTAGE
Case	6847	85	1·2
Andrews	2200	26	·18
Spriggs and Marxer	1000	38	3·8
Cryderman ..	770	40	5·19
J. C. McMillan (quoted by Maclean)	653	10	1·5

are only efficient in diagnosing a minority of diverticula. The two cases I record above occurred, roughly, in a period during which 80 subjects were dissected at Oxford, although I do not suggest that all the duodena were examined minutely for the presence of diverticula.

Incidence of Diverticula in the Duodenum Compared with Other Parts of the Alimentary Tract (*Table III*).—Here the discrepancies between different observers are greater. The old order of frequency, enunciated by Buschi, was colon, ileum, œsophagus, pharynx, duodenum, stomach, while it was commonly stated that Meckel's diverticulum and duodenal diverticula occurred in about the same proportion—that is, in 2 per cent of adults. This latter figure is corroborated roughly in Bunting's post-mortem records, but not by the radiologists.

Table III.—COMPARATIVE FREQUENCY OF DIVERTICULA IN DIFFERENT PARTS OF THE ALIMENTARY TRACT.

AUTHOR	ŒSOPHAGUS	STOMACH	DUODENUM	JEJUNUM AND ILEUM	COLON
Bunting (2600 post-mortems) ..	—	—	14	15 (Meckel)	19
Case (6847 X-ray examinations) ..	—	—	85	5	138
Larrimore (3446 X-ray examinations)	9	3	19	3	71

CLASSIFICATION OF DIVERTICULA.

Different observers have attempted to divide these diverticula into groups, either, according to their appearance, into 'true' and 'false', or, according to their supposed origin, into congenital and acquired. I would suggest the following classification as being at once more comprehensive and less committal :—

I. *Primary*, where there is no obvious cause for their appearance. This would roughly correspond to the 'false' group of most, or the congenital group of some, authors.

II. *Secondary*, where there is some cause for their production, such, for instance, as a duodenal ulcer, old or recent, in their neighbourhood, or the traction of adhesions from neighbouring viscera. This is the 'true' or acquired group of different previous writers. The comparative frequency of these two groups appears in *Table IV*, in which all the diverticula arising from the first part of the duodenum may be classed as secondary.

Table IV.—DISTRIBUTION OF DIVERTICULA IN THE FOUR DIVISIONS OF THE DUODENUM.

AUTHOR	NO. OF CASES	'SECONDARY' 1st Part	'PRIMARY' 2nd Part	3rd Part	4th Part
Linsmayer (post-mortems) ..	45	4	41	0	0
Baldwin (post-mortems) ..	15	0	9	5	1
Case (X rays)	85	17	49	19	
Spriggs and Marxer (X rays)	51 pouches in 38 patients	1	30	16	4
Cole and Roberts (X rays) ..	29	3	23	2	1
Cryderman (X rays) ..	50	1	30	19	

III. Further, there is a third small group of pouches, which must be differentiated from either of the above and which are due to dilatation of Vater's papilla or possibly of the bowel wall surrounding it.

The first two varieties differ so markedly from each other in their situation, in their appearance—both naked-eye and microscopic—and in their causation, that they will be considered entirely separately hereafter in this paper.

I. PRIMARY DIVERTICULA.

The diverticula in this group are characterized as follows : (1) By their situation, being only found in the second, third, and fourth portions of the duodenum ; (2) They are often multiple ; (3) They always grow out from the concave border of the bowel ; (4) They are always in relation to the pancreas ; (5) Typically, they are flask-shaped protrusions of the mucous membrane alone through the muscular coats of the bowel, and communicate with the bowel by a constricted neck ; (6) They are found best developed in people over 50 years of age.

1. Any collection of these cases constantly shows that they occur with greatest frequency in the second or descending part of the duodenum, varying from 100 per cent in Linsmayer's series to 72 per cent in Case's or 60 per cent in Spriggs and Marxer's collection of this class of diverticulum. Further, so many of these occur in the neighbourhood of Vater's papilla, that Letulle christened them 'diverticules périvatériens'. If we analyse Linsmayer's cases, we find that, out of 41, only 7 were 1 cm. or more distant from the ampulla, while in Nagel's series of 20 all were located within 3 cm. of this landmark, only 4 below it, and the others on either side or just above it.

2. In all the records of these cases there are some where there was more than a single diverticulum present. In Linsmayer's series, out of 41, 7 showed two, and 1 showed three pouches. Out of Nagel's 20 cases, 6 had two, and 1 had three diverticula. The radiologists do not find multiple pouches so frequently. Case, out of his 68 cases, collects 7 with two to four each ; Cole and Roberts, out of 26, had 2 cases with two diverticula each, while 1 had three. When more than one pouch is present, the commonest occurrence is to find paired peri-Vaterine diverticula on either side of the ampulla. All Linsmayer's 7 cases were of this variety, while Letulle in 1898 said he had seen 5 diverticula arranged like a collar in this situation.

3. These primary diverticula are always found within the duodenal loop. Spriggs and Marxer, in an X-ray examination, found one growing from the convex side and simulating a cholecystoduodenal fistula, but I have found no other instance of this in the literature.

Grant found in the diverticula he described, which were both some distance below Vater's ampulla, that an injected artery bifurcated at the fundus of each sac and sat astride it. To him it looked as if the mucous membrane protrusion had occurred at the point of the bifurcation of a vessel and had carried the bifurcation before it through the muscle wall. I could not confirm this observation in my second specimen, where the smallness of the pouches and the good injection of the vessels show clearly that the terminal arteries pass alternately to the dorsal and to the ventral aspect of the bowel and that the diverticula arise between them.

4. Grégoire has classified these diverticula into three groups, according to their relation to the pancreas : (a) In front of the pancreas and covered by peritoneum : both the diverticula in my second specimen belong to this category. (b) Behind the pancreas in the retroperitoneal tissue : Diverticula 3, 4, and 5 in my first specimen lay here. (c) In the substance of the head of the pancreas : in my first specimen Diverticula 1 and 2 were so situated.

Any peri-Vaterine pouch on the medial side of the common bile-duct must have Wirsung's duct winding round its dorsal side. Whatever their relation to the gland may be, they lie free, so to speak, surrounded by a layer of areolar tissue, and normally can be readily separated from the gland that covers them.

5. In a very great majority of this class the diverticulum is a protrusion of the mucous and submucous coats of the bowel through the muscle, and they have been rightly called 'hernies tunicaires' by Cruveilhier or 'hernies muqueuses' by Rokitansky, or, less happily, 'false' diverticula by many observers. Even the smallest, that I have seen, comes through a definite slit in the longitudinal muscle layer, which appears to form a sort of sphincter round the neck of the sac. They naturally vary very much in their size, from about 1 cm. to 5 cm. in depth—the largest I have seen recorded is 6·8 cm. (Jacquelin and Quénu)—and in their shape, but the majority have a somewhat expanded fundus narrowing to a neck, which opens by an orifice, again of very varying diameter, into the bowel. As one discovers these sacs post mortem or in the dissecting-room, they are usually collapsed and empty, and look like grape skins devoid of their contents, or small collapsed toy balloons. Occasionally they have been found filled with chyme or containing solid particles of food. Two diverticula containing gall-stones are repeatedly quoted in the literature: they are evidently the old cases of Chomel and Harley, which were mentioned earlier in this paper, and do not belong to this class at all. When laid open the interior appears even and smooth— there is no evidence of old scarring—and usually no valvulæ conniventes are seen, although Spriggs and Marxer speak of some pouches in which " the mucous membrane was thrown into folds ".

Microscopical Appearances.—Most of the reports follow very closely what I found in my cases. Thus Greder writes that usually the mucous membrane is thin and atrophied and villi tend to disappear ; Lieberkühn's crypts, although less numerous, extend over the whole extent of the sac ; Brunner's glands may be seen near the orifice, but are rapidly lost. The muscularis mucosæ is always well developed and may be hypertrophied. As a rule these are the only layers present in the wall of these primary diverticula—mucous membrane, muscularis mucosæ, and a thin submucous layer, blending with an adventitia ; the duodenal muscle stops abruptly at the neck of the sac. In a minority of cases authors report a " muscular coat was everywhere distinct " (Jackson, in describing a sac 3·5 cm. deep); while Baldwin found all the layers of the duodenal wall present in all his 15 cases. Certainly many of the cases recorded by Baldwin were very small : taking 10 of his 15, the average depth was only 0·9 cm. Case, Seippel, and Bonneau maintain that it depends on the size of the pouch ; the small ones have originally all their coats, but with increase in size the muscular coat is gradually overstretched and atro- phies. Bariéty would have three types : (1) With a complete absence of muscle coat ; (2) With a thin muscle layer throughout ; and (3) With a muscular coat latticed and split up and disappearing in many parts of the sac. This point—the presence or absence of a muscular coat—is perhaps rather laboured in the literature of the subject, because it has been used in the past to divide up these pouches into 'true' and 'false' varieties : this

is referred to again below. Certainly my primary diverticula, in a very large preponderance of instances, are truly 'false' or mucous-membrane hernias.

Linsmayer in one case found small lobes of accessory pancreas in the wall of a shallow diverticulum. Hanau made the observation in another instance, and this also occurred in Stiles' case (reported by Spriggs and Marxer).

6. It was assumed, on the evidence of post-mortems, that these diverticula were essentially the products of old age. Thus an analysis of Linsmayer's figures show that 12·2 per cent of this class of pouch were found in persons dying under 50, 12·2 per cent in persons between 50 and 60, while 75·6 per cent occurred in persons over 60 years of age. This latter high figure is in part due to the fact that many of Linsmayer's autopsies were performed at the Vienna Infirmary. In Baldwin's series the average age was 59. Good mentions having seen them at a post-mortem on a woman of 26.

The ages at which they have been discovered by radiologists are somewhat lower : Spriggs and Marxer give 55, Cryderman 51·7 years, as average figures, with 20 and 24 as their youngest records respectively. But turning to patients that have been operated upon for this condition, it is surprising to find that the mean age for the 20 operated cases of which I have records is 47 years. The youngest patient was a woman of 27 (Huddy). Further, many of these cases gave a long history of indigestive symptoms—for example, Jacquelin and Quénu's patient, operated upon at 54, had a thirty years' history of gastric trouble.

The presumption from this is that, as Bonneau says, the abnormality, or its *Anlage*, exists in young people, and it is only in those that have worn badly or in those of advanced age that such pouches increase sufficiently in size to become either sources of trouble during life or objects of interest after death. Such growth in diverticula has been noticed by Spriggs and Marxer. In two patients, re-examined by X rays after four and seven years respectively, the development of a pouch from a small to a large size was observed ; while in another case of a woman, age 48, small saccules were seen round the biliary papilla where none had been seen six months earlier by the authors, or twelve months before that by another radiologist.

Sex.—Nearly all collected records show that these 'primary' pouches are more common in females. Putting Linsmayer's, Spriggs and Marxer's, and Cryderman's figures together, we find them occurring in 77 women to 47 men. This preponderance is proved to be more striking still when we inquire into the sex of the operated cases : in this group there are 19 females with but 2 males.

ETIOLOGY.

On attempting to investigate the cause of these 'primary' diverticula one is at once confronted by a mass of different theories, one or two of which may perhaps hold for about the same number of cases, while many of the conditions supposed to be responsible for them have never been found accompanying them.

The 'Acquired' Theory.—The older observers were inclined to regard them as acquired pouches. This assumption largely depended on the fact that post mortem they were found, as a rule, in very elderly people. The

ages given above of those patients operated upon for this condition are a sufficient refutation of the idea that these diverticula occur only in advanced life. They were regarded as either : (1) *Pulsion* ; or (2) *Traction* diverticula.

1. PULSION DIVERTICULA.—Under this heading would fall two groups of supposed causative factors, possibly acting in combination.

a. Intraduodenal Pressure.—Perry and Shaw maintained that the pressure within the duodenum was normally greater than in the jejunum or ileum, owing to the presence of the pylorus, which opposed reflux, and mention an observation of Moore's, who found jejunal diverticula below a partial congenital occlusion at the duodenojejunal junction. I do not know that there is any foundation for this theory. Keith and Jach suggested that chronic obstruction was responsible for their formation, such obstruction being caused, as a sequel to visceroptosis, by the superior mesenteric vessels as they cross the transverse part of the duodenum. In this connection Cryderman mentions that W. J. Mayo found colonic diverticula above an obstructing carcinoma in 31 per cent of his cases. If this were the cause, it is remarkable that in none of the cases of chronic duodenal ileus reported of late years (Hurst, Wilkie, Higgins, and McConnell and Hardman between them record 146) were any pouches found. Again, Jewesbury found no diverticula in a case of congenital stenosis at the junction of the second and third parts of the duodenum, which only admitted a probe.

b. Weak Spots in the Bowel Wall.—

i. *Anatomical.*—Klebs first suggested that there was a relation between the points of entrance and exit of blood-vessels and the sites of origin of diverticula. Following him, Hansemann and Fischer both concluded that the mucosal hernia occurs originally along the path of a perivenous connective-tissue sheath. This theory has been elaborated by Graser in the case of colonic pouches, and by Heidecker in the case of duodenal pouches, both of whom consider that portal venous stasis causes a distension of these veins ; whenever this stasis diminishes, potential spaces will be left in the bowel wall which were previously filled by the congested vessels. Some experiments performed post mortem were thought to have some bearing on this matter. Heschl and Good, by artificially distending dead bowel, caused either a complete rupture (Heschl) or a trench-like furrow with rupture of the circular muscle (Good) at the mesenteric border of the bowel, while in the same way Hansemann and Palma produced artificial small sacculations along the mesenteric border of senile intestine, corresponding to the points of exit of veins. Contradicting these, Chlumsky found in living animals that the bowel always ruptures, under pressure, at its antimesenteric border.

Peri-Vaterine diverticula have been put down to weakening of the bowel wall caused by the entrance of the common bile and Wirsung's ducts (Fleischmann). but Letulle and Nattan Laurier pointed out that in the adult the muscle coat is stronger here than elsewhere.

Linsmayer, who found pancreatic lobules in the wall of a diverticulum, has also found them in the muscular and submucous coat of three normal duodena near Vater's papilla in young subjects. In the discussion subsequent to his paper Helly and Orth both agreed with this. I could not confirm this in the sections of any of the fœtal duodena I examined. Linsmayer

maintains that these aberrant bits of pancreas cause weak spots in the bowel wall, which in later life may allow hernial protrusions to occur through them.

ii. *Pathological.*—Roth found in one case of diverticulosis fatty degeneration of the mucous membrane and muscle of the neighbouring intestinal wall. It occurred in an old man who had an ulcer scar in the first part of the duodenum. This observation has not been confirmed by others; in my case of five diverticula, sections of the duodenal wall near the pouches and elsewhere showed no evidence of fatty change.

As a cause of this class of primary diverticulum old ulceration can be briefly dismissed. Not only are ulcers very infrequent in the descending duodenum, but neither do these pouches nor the bowel near their orifices show any evidence of scarring of the mucous membrane. There is, however, a group of cases where the following combination occurred: diverticula in the second part of the duodenum with an ulcer in the first part, or, in one case (Roth), with a cicatrized ulcer of the lesser curvature of the stomach. I have found records of ten such occurrences in the literature, and all, except one (Moore's), were typical peri-Vaterine pouches. While Polgar suggests that abnormal duodenal tone or peristalsis may cause such pouches, it is better, I consider, with Nagel, to regard such instances as coincidences, and not to try to connect the presence of the ulcer above with such apparently primary diverticula.

2. TRACTION DIVERTICULA.—

a. Traction by an atrophic pancreas was suggested by *Roth* as a cause for diverticulosis. In answering this, Wilkie points out that in the most marked cases of pancreatic atrophy recorded there have been no duodenal pouches, while such pouches are always separated by a loose connective-tissue sheath from the pancreas, which is indented by them. Again, it is difficult to understand why such traction on the duodenal wall should be localized at a few spots only.

b. Keith suggested that traction by the common bile-duct, which, stoutly coated and inelastic, has its upper end fixed to the diaphragm by the gastro-hepatic omentum, might, in cases of visceroptosis, pull out the duodenal wall. This, as Wilkie points out, would produce a funnel-shaped diverticulum, with the biliary papilla at its apex, which is very different from anything I am considering at present, and will be again referred to below.

The 'Congenital' Theory.—Most recent writers on this subject have regarded these primary diverticula as of congenital origin. As Nagel says, " Whatever the time or the cause of their appearance, these diverticula are formed on a developmental basis, as they occur at actual or potential congenital weak spots in the bowel wall." When, however, one attempts to collect facts for such an assertion, one is met with a great deal of conjecture and little good evidence. The following facts are made the most of :—

1. The frequent multiplicity of these diverticula.

2. Their occasional occurrence with other diverticula elsewhere in the alimentary tract. Thus, they have been found with Meckel's diverticulum once (Perry and Shaw); with a diverticulum of the œsophagus once (Letulle); of the stomach once (Downes); of the jejunum and ileum five times (Hansemann—400 pouches in all—Seippel, Berblinger, Nagel, and Heidecker);

and of the colon six times (Bell, Akerlund, and Nagel). Downes mentions the case of a woman, age 39, who had a diverticulum in the cardiac end of the stomach, two in the duodenum, and many throughout the small intestine and the whole of the colon.

3. While it is rare to find them in infants or in early life, certain observers report them. Simmonds, in the discussion on Linsmayer's paper, says he had occasionally seen diverticula in the first part of the duodenum in young children, but none occurring lower down, except in older people. Shaw is quoted by Linsmayer—without giving any reference—as having found a duodenal diverticulum in a newborn child above a congenital atresia of the bowel. I fear that these two observations do not help to explain the pouches I am considering, which, as has been said, are found exclusively in the second, third, and fourth portions of the duodenum.

4. The embryology of the duodenum. Keibel and Tandler were the first to call attention to the extraordinary activity of the duodenal epithelium after it has given off the hepatic and pancreatic outgrowths. It proliferates so quickly that the lumen of the bowel is occupied by a series of 'vacuoles', some of which produce outward bulgings into the surrounding mesenchyme and so definite diverticula are produced (Lewis and Thyng, Johnson and Elze). In the jejunum and ileum many more of these pouches occur than in the duodenum. In reconstructing the duodenum and pancreas in a 14-mm. embryo I found such a diverticulum just at the duodenojejunal junction (Fig. 363) and two more farther down in the
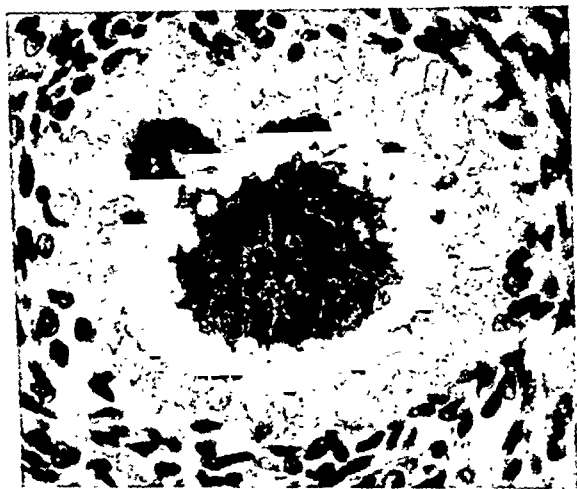
FIG. 363.—A section through, or just beyond, the duodenojejunal junction, showing a diverticulum in an embryo 14 mm. in length. (× 430.)

jejunum. For two reasons most observers are agreed that these evanescent outpocketings—they have disappeared in the 24-mm. embryo, as a rule—can scarcely be responsible for diverticula in the adult, although Johnson found in one case a large persistent pocket in the mid-region of an embryo 134 mm. in length (about 4 months). In the first place none of these pockets occurred in the neighbourhood of the common bile-duct. The one I figure was very similar in position to that in Lewis and Thyng's model, and I would suggest that both of them are rather on the jejunal side of the flexure. Again, in any case, they are situated on the antimesenteric side of the bowel.

As peri-Vaterine pouches are such a common variety of these diverticula, and as I do not think this region has previously been systematically looked at in older fœtuses from this point of view. I examined serial sections of the

duodenum and biliary papilla from fœtuses 6·5 cm., 8 cm., 14 cm., and 16·5 cm. in length, and at full term. I wanted to see: (1) If the muscle coat of the bowel is weakened at the junction with it of the common bile and pancreatic ducts; and (2) If I could find any evidence of abnormal proliferation of the mucous membrane or of aberrant bits of pancreas in its wall. With regard to the ducts, I found apparently two different conditions in different fœtuses. In one, 6·5 cm. in length, the circular muscle appears to be parted so obliquely by the common bile-duct that it looks like the leaves of a partly-opened folding door, and this, I would suggest, is the usual arrangement. In an older one, 14 cm. in length, on the other hand, the muscle seems abruptly interrupted by the duct and there is a small space on either side of the latter where the muscle appears non-existent. Here there do seem potential weak spots, which do not exist in the earlier specimen. My second microphotograph (*Fig.* 364) shows the biliary papilla from a 16·5-cm. fœtus (about 5 months). What strikes one about this is, first, the very large size of the papilla, which bulges so much into the bowel lumen as to make it ∩-shaped; and, secondly, the vessels piercing the muscle on either side of the papilla, not obliquely, but at right angles to it. It may be fanciful, but it appears to me that in this section the stage is set almost for the formation of weak spots on either side of Vater's papilla. A Lieberkühn's crypt has only to grow down a little deeper than usual and it would be very near a perivascular connective-tissue sheath, and by further growth would soon be parting the circular-muscle.

FIG. 364.—A section through the biliary papilla in a fœtus 16·5 cm. in length. At A vessels are seen piercing the muscular layers of the duodenal wall. (× 30.)

These isolated observations of mine do not, of course, prove anything, and, as will be at once recognized, there is much conjecture and no good evidence for the developmental origin of these pouches. As they may occur in any of the three lower divisions of the duodenum, and as they often appear simultaneously in two or in all three divisions, a common cause should be found for them (Wilkie). For this reason, while the passage of the common bile-duct through the muscular wall might account, in the fœtus, for the occurrence of congenital weak areas in this neighbourhood, this could not explain diverticula occurring elsewhere, and one would prefer to suggest a like origin for them all. The common paths that the mucous membrane can take through the muscle are provided by the perivascular sheaths. Hansemann and Fischer first suggested this, but they thought that the whole

process occurred after middle life and that the pouches had no congenital basis. Possibly, as Holzweissig has suggested, this path may be straighter than normal owing to the vessels passing less obliquely, or at right angles, to the muscle. As Fischer points out, once the mucosal hernia has started along the path of a venous sheath, it will follow the path of least resistance, and this may or may not be the sheath of a blood-vessel.

Why should the mucous membrane invade the muscle? There is no evidence as to whether this is due to the actual persistence of vacuoles which should have normally disappeared before the embryo is 9 weeks old, or to an abnormal persistent tendency to epithelial proliferation, or whether, as Payr imagines, there is a congenital weakness of the mesoderm which permits it to do so. Tandler and Forssner suggested that the vacuolization was an expression of unequal growth-rates between the epithelium and the surrounding mesenchyme, and this same explanation would, I think, probably serve as an answer to the above question.

In any case, the pouches we are now considering are probably due to congenital *loci resistentiæ minoris.* At certain places the mucous membrane has pierced, possibly only partially, the muscular wall, and at these spots normal wear and tear will produce pulsion diverticula. Further, the extent to which the mucous membrane has invaded the muscular coat before birth may account for the variation in the condition of the adult diverticular wall. If it has found its way completely through the muscle, the pouch will be the common mucous membrane hernia ; if only partially, the pouch will be clothed by a variable amount of the muscular coat.

Lastly, is there any reason why the first part of the duodenum should be exempt from the incidence of these pouches ? Certainly it is true that the mucous membrane of what will eventually become this portion of the bowel does not proliferate and vacuolize : this only commences just above the level of the emergence of the dorsal (the accessory) pancreatic duct. By the same token, in the adult, valvulæ conniventes are first found at a distance of from one to two inches from the pylorus and at first they are very small and scattered. Possibly both these facts may indicate an inherent difference in the activity of the epithelial growth in the first portion of the duodenum.

PATHOLOGY.

In the great majority of cases these diverticula are found as I have described them—empty sacs, lying in a bed of areolar tissue in relation to the head of the pancreas. They probably owe their comparative immunity from inflammation to : (1) The sterility of the duodenal contents ; (2) Their retroperitoneal situation, which may allow of their easy distension (Greder) ; and (3) The dependent position of their opening into the bowel—this opening, while of varying size, being usually sufficient to ensure the easy emptying of their contents. Again, this opening, in the cases I have examined, was so well concealed by the valvulæ conniventes that only a careful search revealed it, while Case recommends (*see below*) that considerable pressure should be put on the duodenojejunal junction, after a barium meal, to ensure diverticula being filled sufficiently to render them visible on the fluorescent screen. Both these facts make one curious as to whether these sacs are normally filled with

chyme or not.   On the other hand, some of them, once filled, do not empty themselves readily—they have, of course, no muscular coat—and Case found barium retained for seven days in one case.   Such distended sacs can cause either distortion or actual obstruction of the duodenum or of the common bile-duct.

Mechanical Effects of a Distended Diverticulum.—

On the Duodenum.—Jacquelin and Quénu found in a woman with a thirty years' history of digestive trouble a large diverticulum, 6·8 cm. long. arising just proximal to the duodenojejunal junction.   At the operation the distended fundus of this presented between the gall-bladder and the duodenal bulb, and had so deformed the duodenum that its third part ascended almost vertically behind the second part and wholly to the right of the mid-line. With this there was dilatation and stasis of the genu inferius.   Six months after the removal of the sac an X-ray examination showed a normal course for the duodenum and no stasis.   Bauer's case of duodenal obstruction from diverticulosis has been already referred to above.

On the Common Bile-duct.—Bengolea, in 1928, reported the case of a woman who had had three attacks of jaundice.   At the operation he removed a distended gall-bladder and found the bile-ducts free from stones.   Two months later jaundice recurred and further radiography showed a diverticulum near Vater's ampulla.   The author considers that the jaundice was due to intermittent obstruction of the common bile-duct by the retention of intestinal contents in this pouch.

Marie found post mortem, in a case of bilateral peri-Vaterine pouches, a regular dilatation of the common bile-duct without any obvious obstruction, and Specimen 6284.1 in the Royal College of Surgeons Museum shows a pouch 2 cm. above the biliary papilla with some dilatation of both common and cystic ducts.

The commoner way in which these diverticula become pathological is from inflammation in their wall.   Diverticulosis becomes diverticulitis.   Once this has occurred, it may go on to necrosis or perforation of the sac and the neighbouring pancreas may be infected.

Diverticulitis.—In Rosenthal's case, quoted above, the wall of the pouch consisted of granulation tissue without epithelium.   Huddy, in 1923, removed from a woman, age 27, a pouch arising from the second part of the duodenum ; this was thin-walled and black in the centre, while the mucous membrane was necrotic.   Monsarrat, in 1926, found at operation a perforated pouch arising from the posterior wall of the descending duodenum.   With this there was a chronic ulcer of the first part.

Peridiverticulitis.—Case reports an operation at which it was found quite impossible to excise a diverticulum owing to its firm adhesions to the pancreas, while in two out of four of Maclean's operated cases adhesions were found.   In one of these the pouch was embedded in the pancreas, and swabs taken from the raw surface of the latter showed the presence of *B. coli* and staphylococci.

Further, owing presumably to retention, the contents of a pouch may become septic, and this, reaching the duodenum, may cause a duodenitis, and from this an infection of the biliary and pancreatic ducts may follow.

Duodenitis.—Spriggs and Marxer noticed in one case a persistent contraction of the bowel wall below the opening of a diverticulum, suggesting that the duodenum was being irritated by the escaping contents of the sac. Bauer found post mortem a pouch below Vater's papilla, full of greyish fæculent material: the duodenal mucous membrane was red and inflamed, the papilla was swollen with its lips glued together, and there was some dilatation of the common bile-duct. Here should be mentioned a curious case, recorded by Schmidt and Ohly. A woman, age 28, who had had abdominal discomfort from early girlhood and had symptoms of chronic pancreatitis—loose stools rich in fat—was found by the X rays to have a dilated duodenum. This was thought to be due to old gall-bladder adhesions. At the operation the duodenum was dilated to the size of an empty stomach, with some diverticula (there is no record of how many pouches there were or where they were situated). There was no stenosis at the duodenojejunal flexure or any obvious cause for the duodenal dilatation. There was no autopsy, and it is questionable how far the diverticula had any connection with the condition of the duodenum. Again, Melchior found that three out of nine cases of phlegmonous duodenitis had diverticula.

Cholangitis, Gall-stones, and Acute Pancreatitis.—Versmann, in 1919, found in two cases after death stones in the common bile-duct with diverticula just below the papilla. A third patient had had his gall-bladder and the calculi therein removed, the bile-passages being found free. Jaundice, however, persisted, and he had subsequently five unsuccessful operations for this condition between 1914 and 1917. At the autopsy a duodenal pouch was found just below the papilla, which admitted the tip of the little finger. Wilkie, in 1913, published the case of a man who was found post mortem to have biliary calculi and acute pancreatitis, while one inch above Vater's papilla was a diverticulum. In all these cases the authors consider that the diverticula were responsible for the formation of gall-stones.

Chronic Pancreatitis.—Bell found in a woman, who died of arteriosclerosis and gangrene, three duodenal diverticula, one of which was close to the major papilla; further, there was a marked chronic pancreatitis and slight periportal hepatic cirrhosis.

Carcinoma.—As carcinoma of the small intestine is such a pathological curiosity, it is not surprising that, in contrast to W. J. Mayo's finding for the colon (where he found diverticulosis occurring in 31 per cent of cancer cases), no case of carcinoma of these primary diverticula has been recorded. Maclean, however, suggests that, as carcinoma is more prone to develop in an organ that has become cirrhotic, it is conceivable that in some cases of cancer of the head of the pancreas an overlooked diverticulum may be the exciting cause. Schaefer records the case of a man who died of a carcinoma of the tail of the pancreas, in which two diverticula, one the size of a hen's egg, the other of a child's fist, were found in the inferior part of the duodenum.

SYMPTOMS.

There are no certain symptoms or signs which are pathognomonic of these pouches. Bensaude has suggested five predominant groups of symptoms, which may be said to indicate possibly progressive stages of the pathology.

1. **Vague Digestive Disturbances.**—A feeling of heaviness and distension after food, perhaps of nausea, but no actual vomiting; sometimes there is diarrhœa. Typically, there will be a long history of such discomforts, which so often occur in the 'chronic abdomen'.

2. **The Ulcer Type.**—With pain, habitual vomiting, and possibly hæmatemesis. These cases will present a varying amount of epigastric tenderness. Oehnell found considerable pain in 85 per cent of these cases, local tenderness in 29 per cent, and vomiting in 44 per cent. Spriggs found that 5 out of 18 patients with this condition were tender on palpation. The following are some typical case reports :—

Basch (1915) : A woman, age 36, had been troubled with indigestion as a child, 'sour stomach', heartburn, and flatulence. Six years previously she had appendicitis and her appendix was removed. Her indigestion persisted, and in addition she began to have a sharp aching pain below the gall-bladder region one to two hours after food. On examination there was some general enteroptosis and the gall-bladder region was tender on pressure. Chemical examination of the stomach was negative. She was found to have a diverticulum of the third part of the duodenum; there was nothing else amiss in the upper abdomen.

Larimore and Graham (1927) : A woman, age 63, gave ten years' history of gas and distension after meals, diarrhœa alternating with constipation, and vomiting. She had lost 20 lb. in weight and had achlorhydria. She was proved to have a diverticulum of the third part of the duodenum; all else was normal.

Two other occasional and rather curious symptoms should be mentioned :—

a. Hæmatemesis.—Spriggs and Marxer reported that two of their eighteen patients, in whom diverticula were apparently wholly responsible for the illness, had this symptom, while Robineau, in 1921, records the case of a woman, age 39, who, with a history of several years' vague discomfort, suddenly had a very large hæmatemesis. A pouch was found springing from the fourth part of the duodenum and removed; nothing else was discovered to account for the hæmorrhage, and there was no ulceration of the diverticular mucous membrane.

b. Colitis.—Diarrhœa is mentioned as a concomitant symptom in several case reports. Lipschutz records that a woman with two diverticula had a four months' history of this complication. Spriggs noticed it in three of his patients, who also had pain in the left lower abdomen, and suggests that possibly these colitis symptoms are caused by the irritation of putrefactive material from the duodenal pouches. The woman from whom my first specimen came was described as an 'old colitis case'.

3. **Incessant Vomiting.**—In this group the vomiting becomes incessant, suggesting pyloric or duodenal stenosis or, possibly, carcinoma of the pylorus. Haudek records the case of a woman, age 60, who gave a long history of stomach trouble; recently the vomiting had been frequent, with great loss of weight. The X rays showed a diverticulum of the third part of the duodenum and some smaller ones at the duodenojejunal flexure and beyond this. She died as the result of these, and their presence was confirmed at the autopsy, which showed nothing else pathological.

4. Cholangitis Type.—In peri-Vaterine diverticula jaundice of a varying degree may occur, and with it paroxysmal crises simulating biliary colic. Spriggs notes that one case out of his eighteen had attacks of jaundice; Oehnell records one case of cholecystitis out of his thirty-four. The more severe and persistent cases of Bergolea and Versmann have already been quoted.

5. Pancreatitis.—Akerlund's case was that of a woman, age 68, who had a long history of stomach trouble; X-ray examination showed a diverticulum of the third part of the duodenum, which readily emptied itself of barium, together with a dilatation of Vater's papilla and of the termination of the common bile and pancreatic ducts. These still retained barium after twenty-four hours. A few days after this examination she had an attack of intense abdominal pain with repeated vomiting; the right side of the abdomen was rigid and her temperature slightly raised. Directly the acute symptoms had subsided, an operation revealed a necrotic mass in the head of the pancreas, the size of a hazel nut, and further small necrotic centres to either side of this. No duodenal ulcer could be felt and there was no perforation of its wall; the gall-bladder was empty and normal. The necrotic area was drained and a posterior gastrojejunostomy performed, and the patient got quite well.

Case describes the case of a woman, age 45, who had gastric symptoms for six years. A radiogram showed a pocket the size of a hazel nut at Vater's ampulla, in which barium was retained for nine hours, and a diverticulum in the third part of the duodenum. The diagnosis, on clinical and X-ray grounds, was chronic pancreatitis, possible cholelithiasis, and a duodenal pouch. An operation found the diverticulum behind the head of the pancreas, to which it was intimately adherent; the head of the gland itself was enlarged. The diverticulum could not be removed; a cholecystostomy was done and the patient was relieved.

Both Akerlund's and Case's patients, it must be noted, had dilatation of Vater's papilla as well as diverticula. Akerlund maintains that the diverticulum was the primary cause; this set up a duodenitis, by which Vater's ampulla and the ducts were subsequently infected. Case has, however, X-rayed fifteen patients with retention of barium in the ampulla, and in only half of these were duodenal pouches present. The pancreatitis is obviously secondary to the condition of the ampulla, so it is arguable that the diverticulum, in each case well distal to this orifice, had little to do with its occurrence.

Of Oehnell's thirty-four cases of diverticulosis, two were associated with a chronic pancreatitis.

DIAGNOSIS.

No case has yet been accurately diagnosed on clinical evidence. The usual tentative diagnosis is duodenal ulcer, gall-bladder disease, or, in a few cases, chronic pancreatitis. The only method of diagnosing these pouches is radiography after an opaque meal. As Case was the first to discover them by this method in 1913 and has done a great deal of work to perfect its details, I give his technique in his own words :—

After taking the usual barium meal and after a brief examination standing upright, the patient is asked to lie on his right side, so that gravity may aid in filling niches or sacculations in the pyloric zone. When all is ready for the patient to turn over, the observer, standing on the patient's left, makes strong pressure with his gloved left hand over the duodenojejunal junction, at the same time pressing the contents of the stomach towards the pylorus. The patient is then asked to inhale, hold his breath, and turn quickly on his back, while compression of the duodenum is maintained, thus artificially producing obstruction near the duodeno-jejunal junction and incarcerating the duodenal contents. A wooden spoon may be used instead of the hand.

After a pouch is discovered by the fluorescent screen, the following points about it should be noted : (1) its size and shape, (2) its situation, (3) the dimensions of its orifice, (4) its mobility, (5) the length of time the barium is retained, and (6) the relation of the shadow to any point of tenderness on pressure. All writers are agreed on the importance of making frequent screen examinations. Further, Case suggests that a stereoscope may help to show whether the shadow of a pouch is dorsal or ventral to the pancreas.

Shadows cast by primary diverticula will be differentiated :—

1. From barium lodging in the crater of a duodenal ulcer, by the situation of and by the short retention of the opaque meal in the latter, while an ulcer shadow will be tender.

2. From both classes of pouch secondary to ulcers (*see below*), by their situation.

3. From traction diverticula due to adhesions. These will be found, almost exclusively again, in the first part of the duodenum, or if they arise lower down, will occur on the convexity of the bowel wall.

4. Akerlund has drawn attention to the difficulty of distinguishing Vaterine (*see below*) from peri-Vaterine diverticula. He suggests that the shape of the shadow would help, and Baensch says that the fundus of a Vaterine dilatation will be parted into two little bays, corresponding to the termination of the bile and pancreatic ducts.

5. Polgar warns radiographers against certain 'pseudo-diverticula'. Such abnormal shadows may be caused by the bulge of the contiguous duodenal wall towards a scirrhous carcinoma of the head of the pancreas, or by a cholecystoduodenostomy; spastic or organic narrowing of the bowel, secondary to an ulcer, will probably produce a deformity of the whole duodenal lumen.

Larimore and Graham have published the notes of an interesting case in this connection. A man was found by an X-ray examination to have a diverticulum to the left of the second part of the duodenum, in which barium was retained for six hours. At the subsequent operation no evidence of an ulcer or actual pouch was found, but five inches from the pylorus a fold of duodenal wall was bound down by adhesions to the rest of the bowel, forming really a side pocket of it.

The three characteristics of a true diverticular shadow which, according to Bonneau, are sufficiently diagnostic, are : (1) its mobility to the finger. (2) its insensibility on palpation, (3) its persistence. While normally the duodenum is completely emptied in four hours after an opaque meal, a diverticulum will contain barium 11, 24, or 48 hours later, and in one instance it was still evident after the lapse of seven days (Case).

PROGNOSIS.

In contrast to the instances of the grave complications of these diverticula collected from various sources in the preceding paragraphs, it must again be remembered that in the great majority of cases found after death there is no history indicating that they ever caused trouble during life. The first of my cases with five diverticula, three of which are of a considerable size, died in 1927 of pneumonia at the age of 63, and the superintendent of the mental hospital where she spent most of her life writes : " There is nothing in our records bearing on the point you mention, except that she was an old colitis case, but she has not been treated for any complaint for many years, and was a patient here since 1880."

Case, on the other hand, in 1920, pointed out that diverticula discovered during life are in a different category, in that people do not take opaque meals and are not X-rayed unless they are suffering from a certain amount of abdominal disability, while only those pouches that retain barium for a certain time can be so diagnosed. He suggests, therefore, that the diagnosis of a diverticulum generally means surgical treatment. Clairmont and Schinz in the same year said the same thing : " A diverticulum is a source of all possible dangers for its bearer, and is on this account an indication for surgical interference."

The first difficulty, after such a diverticulum has been discovered, is to judge how far it, and it alone, is responsible for the symptoms complained of. Out of Maclean's 16 cases the symptoms could be entirely accounted for by other abdominal lesions in 4, while in Spriggs' series of 38 cases in only 18 were the pouches judged to be the cause of the patient's trouble. Haudek, in 1924, after studying the results of operations for diverticula, went so far as to say that in no case has the removal of the pouch cured the abdominal symptoms for which the operation was performed. For example, Forsell and Key removed a diverticulum successfully from a patient in 1915, but in 1922 Oehnell found that she still had the same symptoms of enterocolitis. Again, Clairmont and Schinz removed a duodenal pouch, but an operation performed ten weeks later owing to continual illness revealed a large carcinomatous ulcer of the pyloric part of the stomach. Only one of Haudek's own cases came to operation. This was a man with a peri-Vaterine pouch. At the operation it was felt, but could not be seen, and, as there was no evidence of any inflammatory changes around it, it was left alone ; a chronic appendix was removed and he was cured for six months. Then he had symptoms of cholelithiasis ; some, I expect, would suggest that the diverticulum was responsible for the latter.

Polgar quotes the case of a man who had had vague gastric symptoms for a year. An X-ray examination showed a diverticulum in the transverse part of the duodenum. Four days later he had an attack of acute appendicitis ; his appendix was removed and he has been perfectly well for the last eighteen months.

Assuming that such other lesions as these have been ruled out and the presence of the diverticulum is believed to be solely the cause of the symptoms presented, are there any guides as to prognosis and treatment ? Such indications may be classified thus : —

1. Attacks of 'diverticulitis', indicated by pain and tenderness on pressure, must be taken seriously. The cause of these attacks is questionable. Bariéty wondered if possibly torsion of a pouch might occur; more probably are they due to distension or over-distension of a pouch, possibly usually empty; or perhaps to some temporary gastric insufficiency, which allows solid particles of food to get into it (Greder). Maclean found these symptoms in 12 out of his 16 cases. At the same time, as Jacquelin and Quénu point out, the case histories show very often that spontaneous cures of all symptoms may occur, and that, if troubles recur, the chance of a fatality is very small.

2. The X rays will help in several ways: (a) The length of time that barium is retained. A pouch that easily empties itself has presumably a wide orifice and is thereby the more innocuous. Case has found that diverticula in the third and fourth parts of the duodenum appear to empty themselves more readily than those about Vater's papilla. (b) Further, is this orifice dependent in the patient's ordinary position? Akerlund has found that a pouch may only fill with barium in the recumbent position. (c) Case suggests that the situation of the pouch in relation to the pancreas is of importance: a pouch of which the fundus lies ventral to the head of the pancreas, is more dangerous than one lying dorsal to it or in its substance. (d) Evidence of dilatation of Vater's ampulla, secondary to a diverticulum (Case and Akerlund). Whenever this occurs, there is the possibility of a cholecystitis or a pancreatitis supervening.

3. The effects of a few weeks' medical treatment. Spriggs found that 13 of his 18 cases were thus entirely corrected, 4 were much improved, and only 1 case—a man with multiple diverticula and achlorhydria—was operated upon (gastrojejunostomy).

I would suggest that the majority of cases belong to Bensaude's first group, and that if any accompanying gastric insufficiency is corrected, they will get along with little discomfort, while the risk of future complications is so slight that it can be practically discounted. Greder, summing up this question, says: " Duodenal diverticula are less serious than a Meckel's diverticulum or than diverticulosis of the sigmoid. Occasionally they give rise to troubles, and exceptionally they menace the lives of patients."

TREATMENT.

The medical treatment which Spriggs has described aims at three things. In the first place, by means of the X rays the best position for the patient to assume in order to allow of easy emptying of the diverticulum is determined, and he is advised to adopt this after meals. Secondly, an attempt is made to keep the bowel and the pouch lubricated and disinfected by means of liquid paraffin and Kerol capsules. Lastly, attention is paid to the digestion, and everything done to tone up the whole alimentary canal. These methods seem to have met with a great measure of success. Case, on the other hand, does not consider that any form of non-surgical treatment will do any good.

I have found recorded in the literature only 23 cases where operations have been performed for primary diverticula (*Table V*). Excision of the pouch, first done by Forsell and Key in 1915, is obviously the ideal treatment. This has been done in 18 of the cases with no fatality ; in one case

Table V.—Twenty-three Cases of Primary Diverticula
Treated by Operation.

Author	Sex and Age	Part of Duodenum	Operation Performed
Maclean	M. 37	Fourth	Excision of pouch
Maclean	F. 58	Second	Excision of pouch
Maclean	F. —	Third	Excision of pouch
Robineau	F. 39	Fourth	Excision of pouch
Rave	F. 53	Second	Gastrojejunostomy with pyloric exclusion
Downes	F. 53	Third	Excision of pouch
Downes	F. 39	Third	Excision of two pouches
Moore	—	Second	Excision of pouch
Akerlund	F. 68	Third	Gastrojejunostomy with drainage of necrotic pancreas
Le Jemtel, Andreoli, and Maratuech	F. 39	Second	Excision of pouch
Jacquelin and Quénu ..	F. 54	Fourth	Excision of pouch
Lecène..	F. 52	Second	Excision of pouch
Forsell and Key	F. 41	Fourth	Excision of pouch
Monsarrat	F. 58	Second	Excision of perforated pouch
Huddy	F. 27	Second	Excision of gangrenous pouch
Basch	F. 36	Second	Excision of pouch and gastrojejunostomy
Schmidt and Ohly	F. 28	Several diverticula	Gastrojejunostomy with pyloric closure
Larimore and Graham	F. 63	Third	Pouch invaginated
Spriggs and Marxer	M. 54	Several diverticula Second and third	Gastrojejunostomy
Stiles (Spriggs and Marxer) ..	—	Second	Excision of pouch
McQuay	F. 34	Second	Excision of pouch
McQuay	F. 40	Second	Excision of pouch
McQuay	F. 78	Second and third	Excision of both sacs

a gastrojejunostomy was performed at the same time. On one occasion the diverticulum was inverted into the duodenum, with death from general peritonitis shortly afterwards. In four cases the pouches were left alone : in two of them a gastrojejunostomy was done : in the other two this was combined with pyloric exclusion, and both the patients died.

The chief difficulty in excising a diverticulum is locating it at the operation, even after this has been done accurately by the X rays, and several failures have been recorded. This difficulty should hardly arise in those that lie ventral to the pancreas, but it may be a very real one in the case of a pouch either dorsal to, or buried in, that gland. Spriggs suggests that the mouth of the diverticulum can usually be found with a finger invaginating the bowel wall opposite to it. Maclean, who was the first to excise one of these buried pouches in 1922, had already opened the duodenum to exclude the possibility of a stone in the lower end of the common duct—the woman had had a previous cholecystectomy for gall-stones and the pancreas was so hard that the duct could not be palpated at all—and was able to find the orifice of the pouch with his finger, and, keeping it there, to dissect out the diverticulum and remove it, after invaginating it into the bowel lumen. This was the only instance of a transduodenal excision of a sac until last year, when McQuay reported the employment of the same method.

In certain cases a localized induration of the pancreas has been a clue to the situation of a pouch buried in its substance. Maclean's method of reaching a peri-Vaterine diverticulum is by mobilizing the descending duodenum and the head of the pancreas. In the case of pouches arising from the third and fourth parts of the duodenum and lying in or dorsal to the pancreas, he turns up the transverse colon and great omentum, thus exposing the third part of the duodenum below the attachment of the transverse mesocolon. The descending layer of the latter is incised along the lower duodenal border opposite the supposed situation of the pouch, the right colic artery being avoided, while the superior mesenteric vessels are retracted to the left. The duodenum can then be turned up enough to expose the pouch, which is dissected out : its neck is ligated and the hole in the duodenal wall is repaired.

II. SECONDARY DIVERTICULITIS.

As was pointed out above, these 'secondary' diverticula, as I have called them, are entirely different from anything that has been considered so far. This group will be distinguished from the 'primary' variety by the fact that they are found, with very few exceptions, in the first part of the duodenum, and by their having, as a rule, a complete muscular coat. They have been found less frequently than these others both post mortem and in X-ray examinations (*see Table II*). For purposes of description, the old division into pulsion and traction diverticula may be employed.

1. **Pulsion Diverticula.**—Pulsion pouches are caused occasionally directly, or more frequently indirectly, by chronic ulceration of the bowel.

a. Diverticula Directly Due to an Ulcer.—Lefèvre and Jonchères found at operation an ulcer on the lower posterior border of the first part of the duodenum, which encircled the orifice of a diverticulum. After a pylorectomy

the pouch was found to have all its muscular coats present, with ulceration of the mucous membrane. Wilkie has recorded three cases of 'ulcer diverticulum', as he called it. In each of these, an inch from the pylorus, in the upper wall of the duodenum, a sac was found formed by dense fibrous adhesions, the bowel wall having been destroyed by ulceration. Here, too, may be mentioned the case recorded by Morrison and Feldman, who found in the mouth of such a diverticulum a small indurated mass with metastases in the neighbouring glands and in the liver. The autopsy showed a primary carcinoma of the diverticulum, which is the only instance of this occurring in the literature.

b. Diverticula Indirectly Due to an Ulcer.—A commoner occurrence is to find diverticula of the first part of the duodenum in close proximity to ulcers or their scars. Baensch has suggested that 'recessus duodeni' would be a more fitting term for these pouches. In these all the coats of the bowel are present, except in one case recorded by Ritchie and MacWhorter, who found at operation a definite duodenal ulcer almost symmetrically opposed to the opening of a diverticulum. This sac looked like a 'gas hernia', with a thin wall, which led down to a small opening in the muscularis.

Usually these out-pouchings occur opposite ulcer scars. Nagel explains this by the fact that ulcers occur commonly along the superior border of the duodenum. If there is subsequent scarring, shortening of this border must ensue, while the corresponding lower border will become redundant and favourable for the formation of recesses. Occasionally, however, they are proximal to an ulcer scar. In Jach's case an obliquely placed cicatrix was found 2 cm. from the pylorus, while between this and the pylorus was the orifice of a pouch large enough to admit the finger-tip. Carman attributes such diverticula to prolonged muscular spasm at the ulcer level. A further probable factor may be changes in the bowel wall in the neighbourhood of the ulcer. Roth found, for example, fatty degeneration of all the coats in the descending duodenum, with a cicatrized ulcer in its first portion.

c. Diverticula Associated with Gastric Ulcers.—In another small group must be placed diverticula in this first part of the bowel associated with gastric ulcers. Chaton has published three cases of this combination, found in pylorectomies; I have found two more in the literature (Murchison and Falconer). In Falconer's case an hour-glass stomach was found post mortem with a diverticulum along the greater curvature of the pyloric canal; a second diverticulum occurred just beyond the pylorus. There was a cicatrix in the upper border of the pyloric portion of the stomach.

2. Traction Diverticula.—While such pathological curiosities as a myoma or an angeioma in the duodenal wall have been said to cause pockets (Hansemann), the common cause of this class of pouch is the pull of adherent viscera in the neighbourhood. For example, Huddy found a gastric ulcer on the lesser curvature which was adherent to a pouch of the first part of the duodenum. Out of nineteen secondary diverticula described by Nagel, three were due to gall-bladder adhesions, while Hunt and Herbst discovered at an operation a fistulous connection between the gall-bladder and a secondary duodenal pouch. Gall-stones had entered the latter, but could not escape into the bowel through its narrow stoma. Harley's case, published in 1857 and

noted above, should probably belong to this category. Again, Nagel has seen two cases where duodenal diverticula were caused by the traction of appendicitis adhesions. All these traction pouches are found as a rule in the first or in the upper portion of the second part of the duodenum, but Wierig has seen them in the third part, as the result of gall-bladder disease.

As the pathology of these secondary diverticula is that of the disease that causes them, they do not, of themselves, give rise to symptoms, and in most cases they have been treated by operations designed to cure the primary trouble. I have found records of 26 instances where pouches secondary to duodenal ulcers have been operated upon. Of these, 12 were removed by pylorectomy; 1 was excised and a gastrojejunostomy was performed; 2 were included in a pyloroplasty; 6 were inverted, and in 3 of these a gastrojejunostomy was done as well; while in the other 5 cases a gastrojejunostomy was alone performed and the pouch was left untouched.

III. DIVERTICULA ASSOCIATED WITH THE MAJOR PAPILLA.

To complete the subject a third variety of pouch must be briefly considered. Under this heading are described two groups of diverticula which differ considerably from each other both in their origin and in their clinical significance.

1. The first of these is caused by the dilatation of Vater's ampulla. According to Baensch this may be a congenital condition, a papilla not being formed, or it may be acquired from an impacted gall-stone in this situation, or is possibly the result of a duodenitis with a complicating cholangitis. The first diverticulum ever described (Chomel) was apparently a dilated ampulla containing gall-stones. This condition, however it is caused, is, as has been already pointed out, important pathologically. Case found it in 15 instances, and in half of these there was clinical evidence of chronic pancreatitis.

2. On the other hand, the major papilla may lie at the bottom of a shallow duodenal diverticulum. This is in many cases a congenital condition, and may be taken as persisting evidence of the original hepatic outgrowth from the bowel. Baldwin writes that in 60 per cent of the adult duodena he examined, the biliary papilla lay at the bottom of a distinct depression. At the same time traction of the common bile-duct, combined with a certain degree of enteroptosis, might well produce a similar condition. Baldwin found an instance of such a pouch post mortem. In a woman, age 61, there was a small shallow pouch 0·2 cm. deep, in the depth of which lay the major papilla. This latter variety of diverticulum cannot, I think, be of any clinical significance whatever.

CONCLUSIONS.

1. The classification of diverticula here suggested is : (*a*) Primary pouches, found without any apparent cause, and confined to the second, third, and fourth parts of the duodenum ; (*b*) Secondary pouches, which are always due either to chronic duodenal ulcers or to the traction of adhesions, and only occur in the first part ; (*c*) Vaterine pouches, associated with the biliary papilla.

2. Primary pouches are probably of congenital origin, although there is no certain proof of this. It is suggested that, at some time during the later six months of fœtal life, an exaggerated downgrowth of Lieberkühn's crypts may reach lacunæ in the muscular coat, where this is pierced by the blood-vessels : the perivascular sheaths of the latter will then provide an easy path for any further extension. From such weak spots pulsion diverticula may arise during adult life.

3. The great majority of these pouches do not cause any trouble, and, since their demonstration by the X rays, their significance has probably been exaggerated.

I should like to thank Professor Arthur Thomson for a great deal of helpful advice, Dr. H. M. Carleton for kindly examining some slides for me, and Mr. W. Chesterman for much assistance and for the production of the photographs.

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A LESION
COMMON TO BREAST AND PROSTATE GLANDS.

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THE following communication is based upon a routine examination of eighty consecutive prostate glands removed for the relief of the ordinary symptoms of prostatic obstruction. It is not proposed to describe in detail all these specimens ; all that is intended is to call attention to a connected sequence of pathological events in the prostate that corresponds to a similar sequence of events that occurs in a certain disease of breasts.

The disease in the breast has been described by Brodie, Schimmelbusch, Reclus, and many text-books, and in the minds of men it has become established under the misleading term of 'chronic cystic mastitis'. Several authors pick out certain parts of the lesion and describe them while omitting others. Few have connected all its manifestations in one compact entity.

In the breast the disease can be seen passing from one stage into another with a complete consistency when all the stages of the lesion occur. The stages in the breast are as follows : First

FIG. 365.—An oblique microscopical section of a prostatic duct under high power. The epithelium is undergoing a desquamative hyperplasia. The epithelial cells lining the duct are becoming elongated and are multiplying and are finally being shed. The colostrum-like cells which have collected in the centre of the distended duct are to be seen in all stages of formation. (× 100.)

there is a cystiphorous desquamative epithelial hyperplasia that ends in shedding dead cells and the formation of large and small cysts : the process may end here. Secondly, there is a transformation of the cystiphorous desquamation into epithelial neoplasia ; the cells are all viable and capable of multiplication : this condition may remain benign ; papillomatous formations are a marked feature of this stage. Thirdly, the epithelial neoplasia may pass on to carcinoma. This is the mode of origin and course of events in 20 to 25 per cent of all breast carcinomata. These events begin in three

successive decades of life. The stage of plasia begins between the late twenties

FIG. 366.—A more advanced stage of the process seen in *Fig.* 365. Two distended ducts are seen cut longitudinally which contain a collection of shed colostrum-like cells. (× 40.)

cystiphorous desquamative hyperand early thirties. The stage of benign epithelial neoplasia begins in the late thirties and early forties, and the stage of carcinoma begins in the late forties and early fifties. When the disease ends in carcinoma all stages are visible in the lesion.

We have noticed indications of the same course of events occurring among the specimens examined of the prostate. At last we have discovered one in which all the stages are exhibited in the same gland. It was also the only carcinoma detected in the series. The carcinoma it contained was unsuspected at the time of its removal. and was discovered during the ordinary routine examination of whole microscopical sections. The patient was 67 years of age and complained only of the usual

symptoms of prostatic obstruction with the usual protracted onset.

Fig. 365 is a drawing of a duct of this prostate under high power; the
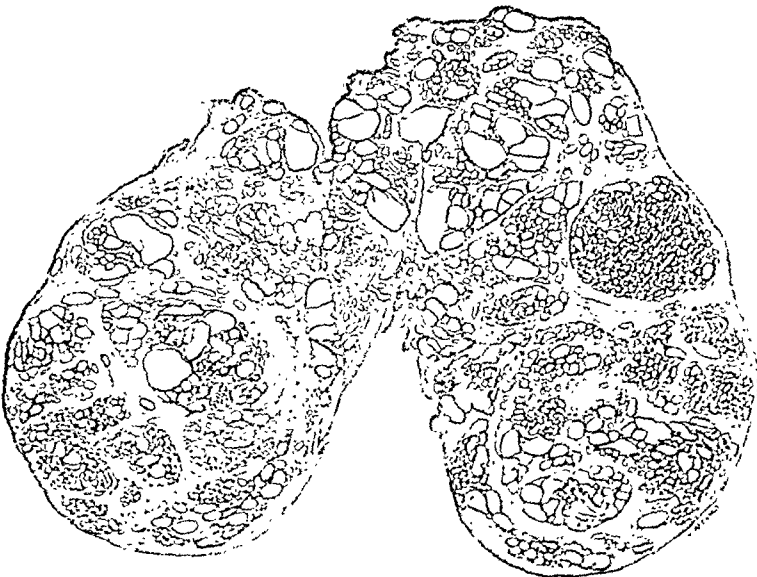
FIG. 367.—Whole microscopic section of part of a prostate that was removed in a multicystic state. The epithelial change was arrested at the cystiphorous stage. There is no sign of epithelial neoplasia in the gland. (× 1½.)

colostrum-like corpuscles are seen in all stages of formation, before and after having been shed. This represents the stage of cystiphorous desquamative epithelial hyperplasia. *Fig.* 366 shows their accumulation within the duct. The cells bear an extraordinary resemblance to the colostrum-like cells seen in the same disease in the breast. Like the disease in the breast it may end at this stage and remain for long periods as a multicystic prostate gland (*Fig.* 367). These cysts are usually filled by straw-coloured or greenish fluid. *Fig.* 368 shows the transformation occurring from the desquamative stage into benign epithelial neoplasia, a condition that is better seen and more complete in *Fig.* 369. In this stage uniradicular and multiradicular papillomata may form (*Fig.* 370) as well as the sessile collections of neoplastic
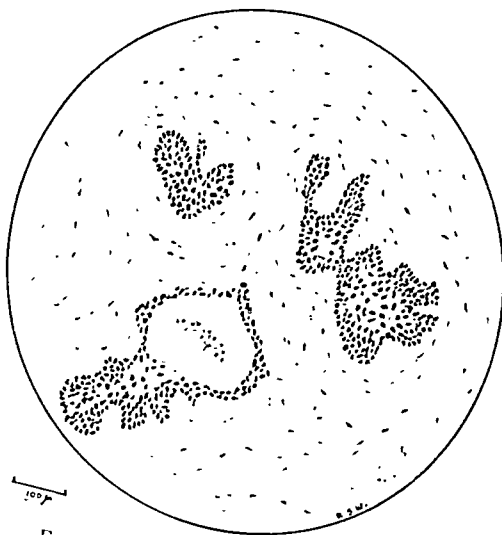
FIG. 368.—The cystiphorous desquamation is in the process of transformation into the stage of epithelial neoplasia in which all the epithelial cells are confined within normal boundaries and are benign in morphological appearance. (× 70.)
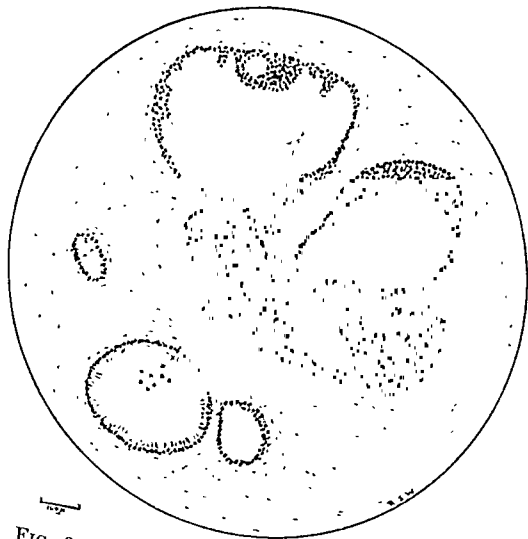
FIG. 369.—The same conditions are seen as in *Fig.* 368. The epithelial neoplasia has become more marked and in greater amount. All the epithelial cells are contained in normal but distended boundaries. It is sessile in parts and does not contain fibrous connective tissue element. Cystiphorous desquamation is still in being. (× 50.)

epithelial cells among which there is no connective-tissue element (*Fig.* 369). The lesion in the prostate, as *Fig.* 371 is a reproduction of part of the carcinomatous area.

Further investigation is essential in order to determine whether the decades of life in which the separate stages of the disease begin in the prostate correspond to those of the breast. The lesion in the prostate, as in the breast, is not related to the formation of fibro-adenoma; it is a lesion affecting the glandular epithelium only, nor are there any signs of an etiological relationship to inflammation. While examining these sections in ignorance of the gland under observation—whether prostate or breast—the observer would have great difficulty in coming to a correct decision as to the source of the material.

Horst Oertel has recorded resemblances between mammary and prostatic changes. He considers them all to be merely senile in nature. We

regard the occurrences of epithelial hyperplasia and neoplasia as pathological changes. The initial stage in the breast, viz., the cystiphorous desquamative stage, begins in the decade between the late twenties and early thirties
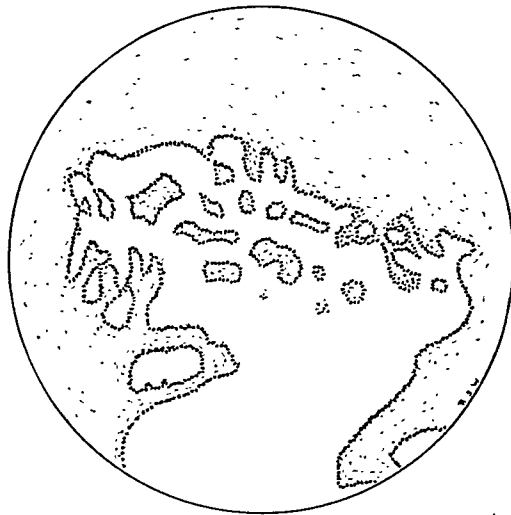
FIG. 370.—The epithelial neoplasia in this prostate gland is papillomatous in formation and the tumour is multiradicular. Many of the tips of its branches are seen in the centre of the cyst. (× 50.)
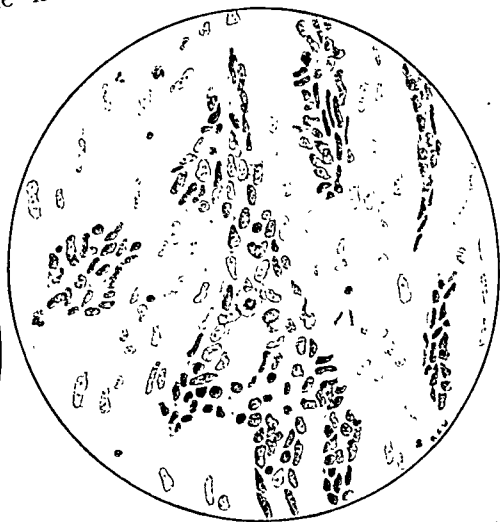
FIG. 371.—The epithelial neoplasia has passed into carcinoma. Collections of epithelial cells are seen among fibres of connective tissue. (× 160.)

and is too early to be regarded as a senile change. The prostate should be an active gland long after the period of any of the changes we have described above if its secretion be essential for the elaboration of semen.

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THE SURGERY OF UNDESCENDED TESTIS.*

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OVER twenty years ago Stansfield Collier demonstrated to me a simple method of placing the undescended testis in the scrotum without detriment to its future existence or development. This operation, depending for its success on a recognition of elementary anatomical facts, I have practised systematically since that time; and I have only refrained from recording the results in the past in the hope that some evidence as to the reproductive functions of such testes would be forthcoming with the lapse of time. It is particularly disappointing to find that no case could be traced beyond ten years; but a study of the results obtained over that period would appear to be worthy of record. Another reason for placing on record the study of this comparatively small series of cases is the pessimism which, based on the failure of surgery in the past, seems to be largely prevalent at the present time.

The failure of orchidopexy, as originally practised, led to the advocacy of two alternatives: (1) Abdominal extraperitoneal replacement; and (2) Removal of the imperfectly descended organ. I have never practised the former method since Stansfield Collier demonstrated to me that the large majority of undescended testes should be amenable to scrotal replacement; while 'removal' probably has few advocates at the present time.

Both procedures were apparently based on the belief in the liability to injury of the retained testis, and on the supposed relationship of the crypt-orchid to neoplasm of the testis. Russell Howard,[1] reviewing a series of 57 cases, concluded that there is an increased liability to neoplasm in the undescended testis; and he quotes Jonathan Hutchinson, jun., in support. This conclusion is disputed by McAdam Eccles. It is probable that the balance of opinion at the present time would support the view that the imperfectly descended testis is more liable to injury, but *not* more liable to malignant disease, than the normally placed organ. Similarly, the rarity of malignant change in the abdominal testis (I have encountered only one instance, which was operated upon by my colleague Mr. Sinclair) negatives the suggestion that this situation is a predisposing factor.

It will probably be conceded, therefore, that there is little to recommend either 'removal' or abdominal replacement of the undescended testis if scrotal replacement can be achieved with a reasonable prospect of satisfactory development and function. Stansfield Collier's method offers such a prospect; and my own results have encouraged me to outline the steps of the operation, and the summary of the lessons to be learned, in the hope that a brighter

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outlook on the surgery of this condition may result. In more recent years the results of a similar procedure, reported by Southam and Cooper,[2] are equally encouraging.

THE OPERATION.

The first anatomical point to be noted is that the spermatic arteries. arising from the aorta, do not pursue a straight course to the inguinal canal. The course of the spermatic veins is equally indirect. Stansfield Collier, by fixing the testis with the fingers and exercising gentle tension upon the cord, endeavoured to mobilize the spermatic vessels towards the mid-line with a finger, gently worked upwards into the abdomen through the internal ring. He demonstrated that very material length to the cord could thus be obtained and many testes brought into the scrotum without undue tension.

The mobilization of the spermatic vessels from the peritoneum cannot in actual fact be effected by any such manipulation. for not only does the spermatic vein receive tributaries from the ureter, but, on the left side, from the iliac and pelvic colon.[3] Further, the close adherence of the ureter to the parietal peritoneum is one of the first points of importance in the surgery of the large bowel, and the adherence of the spermatic vessels to the peritoneum is equally marked. It is therefore impossible. by any blind manipulation, so to mobilize them by separation. If, however. the peritoneum, together with the adherent vessels and the large intestine. be extensively mobilized, the degree of lengthening of the cord obtainable will depend on the elasticity of the peritoneum, and therefore to a large extent on the age of the patient.

The success of the operation of orchidopexy therefore depends largely on two factors : (1) *Adequate mobilization of the peritoneum and attached spermatic vessels*—the object being to make the vessels take a straight course to the scrotum ; and (2) *The age at which operation is undertaken.* The younger the subject. the more elastic is the peritoneum. Against this must be considered the increased vulnerability of the vessels in the young. and consequently the risk of damage to the blood-supply of the testes.

The steps of the operation are simple. The incision is that employed for inguinal hernia. The external oblique is divided to a point just above the internal ring.

If the testis is lying in a patent processus vaginalis, as is most commonly the case (*Fig. 372*). it is brought outside the everted sac. and gentle traction

Fig. 372.—Testis lying in the open sac.

is exerted on it to render the cord a little taut. The sac is split to the internal ring (*Fig.* 372), and at this point it can be easily separated with great gentle-ness from the cord and vas, and ligatured. The separation should extend well into the abdominal cavity. The point to choose for this separation is at or above the point where the vas leaves the vessels and turns inwards (*Fig.* 373). As a rule it is useless to attempt such a separation below this point ; for the delayed development of cord, vas, and epididymis, together with the delayed descent of the testis, is associated with the defective development of the peritoneum. This is thin, friable, and adherent. Above the deflection of the vas, however, separation is always possible, and can be extended well into the abdominal cavity (*Fig.* 373). If the testis lies in a normal tunica vaginalis, this may be opened and the testis brought outside, the sac being evaginated. A search is then made for a patent funicular process or definite hernial sac, either being appropriately dealt with.

Fig. 373.—Separation of neck of sac at the point where the vas leaves the cord to turn inwards.

In all cases the gubernaculum is divided between ligatures so that the testis is completely free. Gentle traction is now exerted on the testis while
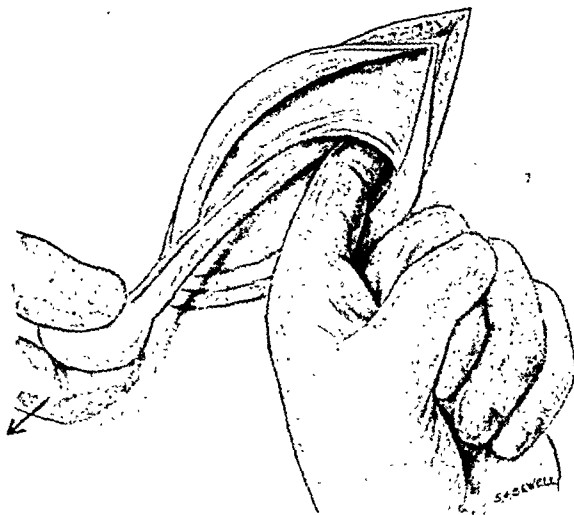
Fig. 374.—Mobilization of the peritoneum.

the forefinger is gently worked up into the abdominal cavity, mobilizing the peritoneum anteriorly, internally, and downwards, until the vessels can be

felt projecting anteriorly into the abdominal cavity and nearer to the mid-line

(*Fig.* 374). This manœuvre can be continued as far up and as extensively as is necessary to bring the testis easily into the scrotum. In some of the worst cases the connective tissue of the cord may be completely divided so that only the vessels and the vas remain intact (Southam and Cooper[2]). This, in my experience, is rarely necessary and usually inadvisable.

In some instances the testis and cord have been brought into the scrotum through a stab-wound in the conjoined tendon before suturing this tendon to Poupart's ligament (*Fig.* 375).

The Fixation of the Testis in the Scrotum.—With the forefinger a passage is forced well into the scrotum

FIG. 375.—Cord brought through stab-wound in conjoined tendon, and suture of Poupart's ligament to to the tendon.

to make an effective bed. While tension is so exerted on the skin of the scrotum a straight needle threaded with salmon gut is passed from without through the scrotal bed into the inguinal canal, the finger acting as guide (*Fig.* 376). The stitch is passed through the firm tunica albuginea at the lower pole of the testis between it and the epididymis. With a pair of dissecting forceps the skin of the scrotum is picked up at the point where the stitch entered, and (the finger again acting as a guide) the skin of the scrotum is invaginated into the inguinal canal. The needle is passed outwards again at this point. These trivial details seem perhaps to be unduly laboured ; but it is most important that the ingoing and outgoing stitch shall follow accurately
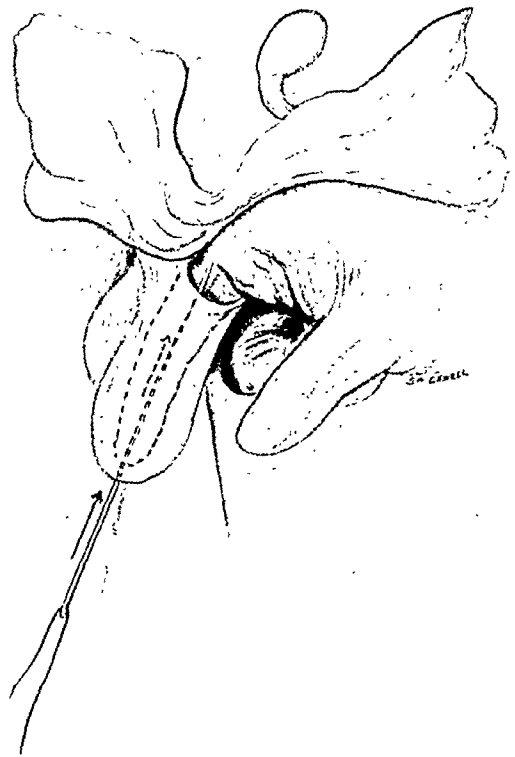
FIG. 376.—Preparation of scrotal bed by the finger, guided by which the needle is shown passing upwards.

the artificial tunnel into the scrotum. This ensures that no areolar tissue barriers shall prevent the easy descent of the testis into the scrotum or hamper its maintenance in that situation. The stitch is then passed through the inner side of the thigh, over a small roll of gauze (*Fig. 377*). Finally the suture of the external oblique and the skin completes the operation.
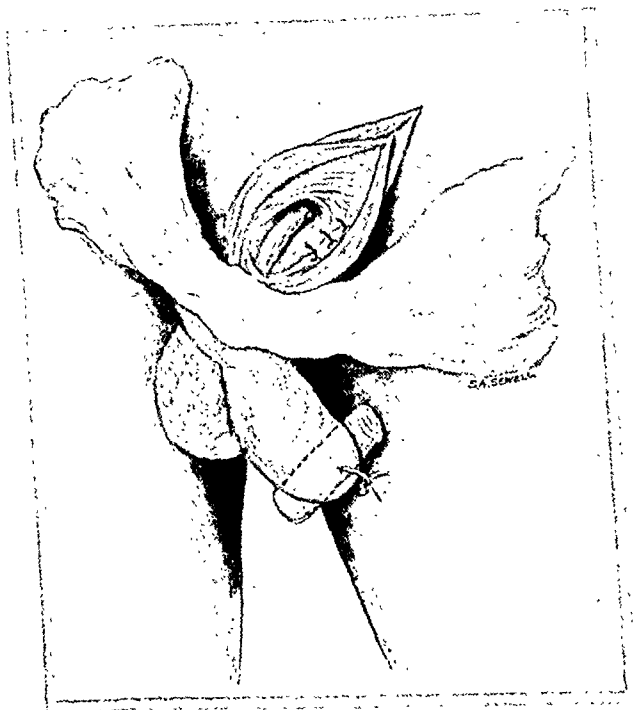
Fig. 377.—Fixation of testis in the scrotum by a suture which passes through the thigh.

Subsequent History.—There is always a considerable degree of swelling of testis and cord following the operation. The inguinal stitch is removed on the eighth or ninth day, and the stitch in the thigh remains in from ten to fourteen days. For a month or six weeks—sometimes longer—the swollen testis may often lie in the neck of the scrotum close to the pubis. As time goes on it slowly descends into the scrotum, and in favourable cases both testis and cord approach the normal. This is usually achieved in from five to six months.

I have been able to collect the notes of twenty-eight cases (thirty-three operations) in which the immediate results were satisfactory. In one instance the patient refused to come up for examination as he " was quite well ". In two further instances there has been no reply to repeated inquiries. The results of the remaining thirty operations have been ascertained after varying periods of over one and a half to ten years.

There are three types of cases in which the testis does not lie in the scrotum : (1) *Post-operative retained testis ;* (2) *Mobile testis ;* and (3) ' *Undescended testis* '.

1. POST-OPERATIVE RETAINED TESTIS.

During the operation for hernia (especially in fat infants with 'mobile testes'), if care is not taken to ensure the presence of the testis in the scrotum before the final sutures are completed, it is not at all impossible for the testis to be caught up in the inguinal canal. It has fallen to my lot on several occasions to release and replace in the scrotum a testis retained by such an accident. One case is quoted as an instance.

E. A. J. W., age 25 years. The patient gave a history of radical cure of double inguinal hernia in early childhood. No note of any abnormality of the testis previously. After the operation the right testis was noticed by the parents to be absent from the scrotum. At the operation (over twenty years later) the testis was easily freed—without mobilization—and placed in the scrotum. It was normally developed and in normal relationship with the epididymis, though it was rather smaller than that on the left side.

There is no question that this was an example of accidental post-operative retention in the inguinal canal. But it is instructive as an instance of the possibility of a practically normal development of the testis in the inguinal canal—as judged by clinical examination.

2. MOBILE TESTIS.

So frequently is this condition mistaken for 'undescended testis' that no classification is complete without mention of it.

The cremasteric reflex is stimulated by exposure to cold, examination, bathing, etc. By this stimulus the testes retract—in some instances into the inguinal canal. Children with a pronounced reflex are very frequently presented as suffering from undescended testis, inguinal hernia, irreducible (and on occasion strangulated) hernia. On examination the testis is not in the scrotum, but can easily be replaced into its normal position with patient manipulation. The condition is physiological and requires no treatment. The frequency with which mistakes in diagnosis are made is sufficient apology for referring to this class of case.

In one practical respect, however, the mobile testis is important. Sometimes the stimulus of examination causes the retraction of the testis into the inguinal canal, where it presents a swelling which is evanescent and often leads to a diagnosis of hernia—a point to be remembered if mistakes are to be avoided.

3. UNDESCENDED TESTIS.

This short series of cases has demonstrated that there are two quite distinct types of undescended testis: (*I*) The testis lying in its own tunica vaginalis, either not associated with a hernia, or completely independent of an associated hernial sac; (*II*) The undescended testis lying in a patent processus vaginalis.

Type I.—THE UNDESCENDED TESTIS LYING IN ITS OWN TUNICA VAGINALIS AND UNCONNECTED WITH A HERNIAL SAC.

There are seven cases of this type in the present series, embracing nine operations.

Case 1.—E. L., age 13½ years. The doctor at school noticed the right testis was undescended. On examination, the organ could just be brought to the neck of the scrotum. No hernia seen.

March, 1921.—Usual exposure. Patent funicular process, unconnected with the testis, transfixed and ligatured. Undescended testis found, mobilized in the usual manner, and brought through an opening in the conjoined tendon into the scrotum. Suture to the thigh and completion of operation as usual.

March, 1929.—Right testis perfect. Size, consistence, elasticity, and elements of the cord in every respect identical with the left side.

Case 2.—J. W. N., age 9 years. Scrotum developed, but empty. Slight swelling in both inguinal canals on coughing. Rings a little large.

December, 1923.—Operation on right side. A well-developed testis was found, but no hernial sac. Usual mobilization and fixation.

September, 1925.—Operation on left side by another surgeon. Small sac isolated and removed. Testis, in inguinal canal, freed and brought 'easily' into the scrotum. Mobilization was not practised.

1928.—Result: right side (mobilization)—perfect; left side (no mobilization)—poor (Fig. 378).
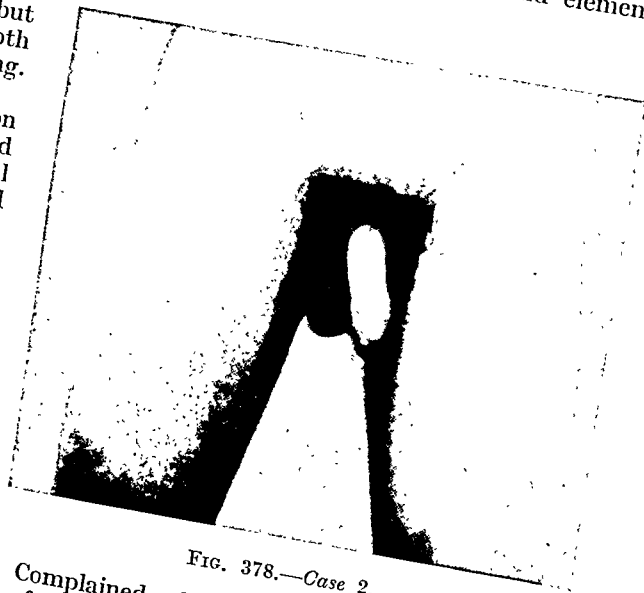
FIG. 378.—*Case 2.*

Case 3.—G. M., age 9 years. Complained of right undescended testis. On examination there was no evidence of hernia. The right testis could not be felt or seen; the left testis was at the neck of the scrotum.

June, 1924.—Operation on right side—usual exposure. Small potential sac (unconnected with the testis) separated and ligatured. Usual mobilization and fixation of the testis.

May, 1926.—Right testis satisfactorily in scrotum. Left testis still at the neck of the scrotum.

September, 1927.—Left orchidopexy in usual manner.

June, 1928.—Final result: good both right and left. Left testis is a little lower than the right.

Case 4.—R. S., age 5 years. Complained of right undescended testis. On examination the right testis was in the inguinal canal. No hernia was detected.

November, 1925.—Operation on right side disclosed a small sac. The testis was easily replaced and fixed in the scrotum in the usual way, after full mobilization.

February, 1929.—Right testis is of normal size and consistence. Comparison of right and left sides shows the cord, epididymis, and testis approximately identical except that the right is a trifle smaller than the left.

Case 5.—D. B., age 8 years. Complained of double undescended testis. On examination testes not palpable in scrotum or inguinal canals.

December, 1927.—Operation on right side. Usual exposure. Very small sac isolated and ligatured. Usual mobilization and fixation of testis in scrotum.

1928. Excellent result. Left side not yet operated on.

Case 6.—M. F., age 10 years. Double undescended testis. Right side can be brought down lower than the left. Impulse right and left on coughing.

Feb. 9, 1928.—Operation on right side. Testis found inside internal abdominal ring. Small funicular process freed and ligatured. Usual mobilization enabled the testis to be brought into the scrotum *with considerable tension*. Right leg kept flexed to about 30° and gradually straightened from day to day.

June, 1929.—Testis in scrotum; size normal; elasticity good. Apparently normal testis for age.

Case 7.—G. M., age 13 years. Complained of right undescended testis. Testis could be brought just to the brim of the pelvis. Left side normal.

May 8, 1928.—Operation on right side—usual exposure. Testis lying in a normal tunica vaginalis. No hernial sac found. Extensive mobilization rendered the testis *replaceable in the scrotum with considerable difficulty*. Thigh flexed after usual fixation and gradually straightened during the next few days.

October, 1928.—The testis was thickened and hard and lay just under the pelvic brim.

June, 1929.—The testis lay at the bottom of the scrotum. The elements of the cord were easily distinguishable; consistence and sensation were apparently normal.

Type II.—The Undescended Testis Lying in a Congenital Hernial Sac.

This is quite the commonest variety of undescended testis, the series embracing seventeen cases and twenty-two operations.

Case 8.—L. M., age 9 years. Complained of double undescended testis. No hernia seen.

Oct. 16, 1919.—Usual exposure. Testis lying in patent processus vaginalis. Sac found and ligatured at internal ring. Usual mobilization and suture to thigh.

February, 1929.—Right testis lying free in the *fundus* of the scrotum and as fully developed as the left. Left testis lies at the *neck* of the scrotum and is associated with a large hernia. Consistence, sensation, and sexual development appear normal (age 19 years). Elements of cord are distinguishable and appear normal.

Case 9.—R. J. H., age 6 years, 10 months. Complained of double undescended testis. Mother noticed scrotum undeveloped at birth and testes not descended.

Jan. 8, 1920.—Right hernial incision. Small testis in patent processus vaginalis. Usual isolation and ligature of sac; mobilization of testis and cord, and scrotal fixation.

1928.—Right testis normal and developing according to age (15 years). Left testis not in scrotum : never operated on. Sexual development appears normal.

Case 10.—C. D., age 6 years, 4 months. Complained of double undescended testis and hernia. Only child, had suffered from mumps. Complained of right undescended testis and hernia. On examination the right testis was found to be in the inguinal canal.

February, 1921.—The notes contain no comment on the condition of the testis, but the usual operation was performed.

June, 1928.—From a clinical examination the testis (lying on the pelvic brim) appears to be completely atrophied.

Case 11.—G. H. P., age 8½ years. Complained of double inguinal hernia and undescended testes. On examination the right hernia and undescended testis were felt. Left testis not palpable.

November, 1921.—Usual operation.

1928.—Apparently a normal well-developed testis in the scrotum on the right side. The left testis (not operated upon) is small and undeveloped, and lies just below the brim of the pelvis : there is a hydrocele below it. Sexual development appears to be normal.

Case 12.—N. J. B., age 6 years. Complained of right inguinal hernia and double undescended testes. The child's mother noticed a lump on right side, reducible, but growing larger. The doctor noticed double undescended testes. Examination showed double undescended testes and right inguinal hernia.

July, 1922—First operation: usual procedure on right side. Second operation: left side (by another surgeon). No mobilization. Testis small and lying in processus vaginalis. Cord could not be separated from sac; sac closed; testis fixed to thigh.

1928. — Right side (mobilization)—good result; left side (no mobilization)—failure (*Fig.* 379.)

FIG. 379.—*Case* 12.

Case 13.—J. D., age 11 years. Only child. Complained of right inguinal hernia and undescended testis. Left side normal. On examination the right testis was at the external ring and could only be brought to the pelvic brim.

January, 1924.—Testis lying in patent processus vaginalis. Usual procedure.

June, 1928.—Testis *fairly* developed—not so fully developed as left. Testicular sensation equal on both sides. Right less developed than left.

Case 14.—D. P., age 8 years. Complained of double undescended testes.

December, 1924.—Usual operation on right side. Immediate result satisfactory.

June, 1926.—Left side operated upon as the right was so satisfactory. Usual procedure.

June, 1928.—Right side—result excellent; left side—testis undeveloped.

FIG. 380. —*Case* 16.

Case 15.—W. S., age 11 years. Complained of undescended testis.

March, 1925. — Usual operation. Testis found almost 'intra-abdominal'.

June, 1928.—No atrophy. Left testis smaller than right; otherwise appearances normal on examination. The testis seems to be developing well, though it is not so low in the scrotum as the right.

Case 16.—J. R., age 7 years. Complained of double undescended testes. No hernia seen.

November, 1925.—Usual operation on right side.

October, 1927.—Left orchidopexy by another surgeon.

June, 1928.—Right side, normal and in good position. Left side (imperfect mobilization), testis a little hard and lying high (*Fig.* 380).

Case 17.—D. P., age 6 years. Complained of double undescended testes. Both could be felt in the inguinal canals.

November, 1925.—Usual procedure on right side.   Immediate result satisfactory.
1928. — Testis cannot be felt.   Probably complete atrophy.   No further operation.

Case 18.—A. D., age 2½ years.   Complained of right inguinal hernia ; noticed at 7 weeks and increasing in size.   Examination showed right inguinal hernia and undescended testis.   Testis palpable high in the inguinal canal.

March, 1926.—Usual operation on right side.   Testis lying on internal oblique.   Testis replaced in scrotum *without tension*.

May, 1928.—Result poor. Small testis and epididymis palpable.   Probably delayed development (cf. age) and associated atrophy.

Case 19.—D. H., 9 years. Complained of double undescended testes.   On examination small atrophic testes were felt in the inguinal canals.   No hernia seen.

Fig. 381.—*Case* 19.

April, 1926.—Operation on right side by the usual method.   Testis found in thin-walled sac   Replacement in the scrotum *without tension*.

June, 1928.—Result good (*Fig*. 381).

July, 1928.—Left testis *not* felt.   Operation on left side disclosed the testis in hernial sac.   Usual procedure.

January, 1929.—Both sides very satisfactory (*Fig*. 382).

Case 20.—C. B., age 8 years, 3 months.   Operation at another hospital for right inguinal hernia when 19 months old.   On examination the testis was misplaced and painful ; child vomited at times.   Testis could be felt at the external ring.

March, 1926.—Operation on right side.   Testis found bound to the external ring by fibrous adhesions.   It could not be brought into the scrotum until after *extensive mobilization*.   Then replacement was carried out *without tension*.

1928. — Fair result.   Some testicular atrophy.

Case 21.—N. G., age 6 years, 5 months.   Complained of right undescended testis.   Left side normal.   On examination the right testis was found lying below the external ring above the pubis.

September, 1926.—Operation on right side.   Testis lying in hernial sac.   Usual procedure.   Testis easily replaced in scrotum after mobilization.

June, 1928.—Result perfect (*Fig*. 383).

Fig. 382. -*Case* 19.

Case 22.—C. W., age 8 years, 4 months. Complained of double undescended testes. Examination showed the right testis to be mobile ; left testis undescended. Operation on left side disclosed a very undeveloped testis in a patent processus vaginalis. The vessels were very small and the vas no larger than a thread. Necessary mobilization was extensive, and replacement was associated with some tension. Prognosis was considered doubtful.

February, 1929.—Atrophy.

Case 23.—R. S. T., age 11 years. 5 months. Complained of double undescended testes. On examination neither testis could be definitely felt.

July, 1928.—Operation on right side. Testis very high (almost intra-abdominal) in patent processus vaginalis. Usual operation, and the thigh flexed as there was some tension. Thigh straightened gradually in a few days. Prognosis guarded.

September, 1928.—Right side so satisfactory that operation was undertaken on the left side. Extensive mobilization caused a peritoneal tear which had to be sutured. Testis sutured in position with considerable difficulty.

Fig. 383. *Case 21.*

1929.—Right side : shape, elasticity, and consistence normal. Elements of the cord distinct, though slight thickening is left. Left side : testis is still a little high, and a little more thickening of the cord is detected than on the right side. Otherwise both results are good.

Case 24.—W. H. F., age $6\frac{1}{2}$ years. Complained of a lump in the right groin.

1926.—Operation for right hernia by the house surgeon. Testis found small and atrophied. Radical cure of hernia ; testis freed and brought into the scrotum (with difficulty) and fixed to the thigh in the usual manner.

July, 1928.—Admitted for undescended testis which could be felt at the external ring. Operation (kindly performed for me by Mr. Denis Browne): dense adhesions held the testis in the inguinal canal. About an inch of the original silkworm-gut suture *in situ* was removed. After the usual mobilization the testis could easily be secured in the scrotum.

1929.—Good result. Hardly any difference detected between the two sides.

DISCUSSION.

In estimating the results of operation, not only is the position of the testis in the scrotum taken into consideration, but due weight is given to the size and consistence of the testis. its relationship to the epididymis, the elements of the cord. and (when possible to estimate) testicular sensation. In this small series of twenty-four cases there were thirty-one operations. The end-results from one to ten years later are as follows :—

Perfect results	..	20	=	about 66 per cent	
Fair results	..	3	=	„ 10	„ „
Poor results	..	5	=	„ 16	„ „
Atrophy ..	..	3	=	„ 10	„ „

Perfect Results.—It is significant that, of the twenty perfect results, one case was operated upon for the second time. On the first occasion the

operator did not practise peritoneal mobilization, and failure resulted; at the second operation success followed adequate mobilization. This case showed also that without mobilization atrophy may not necessarily result; but the testis may ascend again into the inguinal canal—in this instance the salmon-gut fixation suture was drawn up with the testis and was removed at the second operation.

Fair Results.—By this is meant a normal testis and cord which has either not developed to a size equal to the normal, or an organ which, though apparently normal, does not lie so low in the fundus of the scrotum *as on the* unaffected side. In this group there were two boys operated on at 11 *years old* ; and in the third instance a second operation was undertaken after initial failure due to a neglect of the *principle of mobilization*.

Poor Results.—In this group are included those testes which, though not atrophied, are small, imperfectly developed, and similar to their state before operation. Of these five cases, in three instances *mobilization was not practised* ; of the other two, one was 10 years old and the other 2½.

Atrophy.—This occurred in three instances. In one the testis and cord were noted as diminutive and the vas is stated to have been no larger than a thread. It is noted that the prognosis was very doubtful in view of the very extensive mobilization necessary to bring the testis into the scrotum. It is possible that this is the one instance in the series (which would amount to about 3 per cent in all cases) when scrotal replacement was impossible and abdominal replacement indicated.

Two very important issues are raised by this preliminary analysis :—

1. The Necessity of Adequate Mobilization.—Excluding atrophy, there were eight instances of results which fell short of the normal in some respect. Of these eight cases mobilization was not practised in three, and one was a second operation undertaken to remedy failure from this omission. About one-third of the indifferent results and failures may be attributed to this cause.

2. The Age at which Operation is Undertaken.—Of the remaining four imperfect results, the age was over 10 years in three cases, and 2½ in one. The average age at which a perfect result was obtained is about 9 years. Though the figures are too small for statistical purposes, it would appear both from results and from operative experience that, mobilization being more difficult to achieve (owing to diminishing elasticity of the peritoneum) with increasing age, the prognosis becomes progressively worse with increasing years. This is shown by the following table :—

	Over 10 years	
Perfect results ..	35 per cent	
Fair results ..	100 ,, ..	(excluding one secondary orchidopexy)
Poor results ..	66 ,, ,,	

While, therefore, the age of 9 years may be accepted as the limit of the most favourable time for operation, and since a perfect result can be obtained at the age of 5 years, attention must be drawn to the case operated on at 2½ years. This resulted in a very poorly developed organ. No doubt the manipulation necessary for scrotal replacement is too severe for the structures at this age. Accordingly the writer's experience has led to the conclusion that *the most favourable age for operation is from 5 to 9 years.*

Before passing on to a more detailed analysis of the lessons to be learned from this series, attention may well be called again to the first table of results above. Under the heading 'fair results' are included testes which are not far short of perfect, and which appear to be developing into normal organs. If, then, these two groups are taken together; and if the poor results and cases of atrophy are classed as failures; the following rough table may be accepted as generally indicating the proportion of successful results to be expected:—

Perfect	..	66	..	Satisfactory	=	76
Fair	..	10				
Poor	..	16	..	Failure	=	26
Atrophy	..	10				

Southam and Cooper[2] have in recent years practised a similar operation to the one described, based on the principles which guided Stansfield Collier. It is curious to note that they claim 72 per cent of successful results, and 28 per cent of failures. The close agreement of the figures is an additional confirmation of the desirability of operating on these cases.

Classification.—It will have been noticed that two types of undescended testis have been differentiated : *Type I*—When the testis, lying in a normal tunica vaginalis, is not a content of a patent processus vaginalis ; and *Type II*—When the testis lies in a patent processus vaginalis. There is a marked difference in these two types, and though such a distinction may be difficult to establish clinically, its appreciation is of importance.

Type I.—Sir Arthur Keith[4] describes the development of the gubernaculum and its influence on the descent of the testis as follows :—

In the fourth month the deep muscular layer of the abdominal wall, composed of the internal oblique and transversalis, buds inwards and expands the plica gubernatrix [which continues the common urogenital mesentery to the groin] with muscular and fibrous tissues. [This joins up and seizes the caudal pole of the testis]. The gubernaculum grows downwards as a solid fibromuscular mass, until it reaches the subcutaneous tissue which at that time completely fills the scrotum. Its attachment to the scrotum is slight and easily broken. The gubernaculum, as it grows through the abdominal wall, carries with it : (1) A process of peritoneum (the processus vaginalis) ; (2) The transversalis fascia (the infundibuliform fascia) ; (3) The internal oblique and transversalis muscles to form the cremaster ; (4) The spermatic fascia from the external oblique ; (5) The deep layer (Scarpa's) of the superficial fascia of the groin.

It will thus be seen that the gubernaculum testis is an actively growing mass of fibromuscular tissue which, starting from the inner muscular layer of the abdominal parietes in the groin, invades first the plica gubernatrix and then the abdominal wall itself, every layer of which it carries as a prolongation within the scrotum. *It is an invading army of cells.* It draws with it into the scrotum the peritoneum in the iliac fossa, on which the testis is dragged like a log on a sledge.

It will be appreciated that Keith holds no brief for views which would assign to intra-abdominal pressure, and other equally doubtful agencies, a rôle in the process of descent of the testis. He regards the descent into the scrotum as an integral part of development.

Arrest of descent is commonly a symptom of arrest of testicular development. On the other hand, the testicle may assume an *ectopic position.*

The gubernaculum ends in the scrotum principally, but bands of it pass to end in the root of the penis, in the groin and in the perineum. These bands, normally slight, may be big enough to influence the descent of the testicle.

In this class it is to be noted that the scrotum is often developed though it is empty. Further, the testis is usually found to be well developed and in normal approximation to its epididymis. The development of a normal tunica vaginalis and the absence of a hernial sac complete the picture of a normally developed testis and cord such as is found in cases of 'ectopic testis'. It would appear, therefore, that in this class the failure of descent is not part of a general failure of development, but only a failure of the gubernaculum in its scrotal position, and a consequent shortening of the elements of the cord. In a word, the fourth position of the ectopic testis (all being due to a failure of the gubernaculum) is in the inguinal canal.

It is significant that in this series of seven cases (nine operations) 100 per cent were perfect results when mobilization was practised ; the only poor result was where mobilization was omitted.

Finally, the average age at the time of operation was 10 years (as against the average $8\frac{1}{2}$ in *Type II*); so that, in spite of the age disadvantage, the results were much better.

All the evidence supports the view that in *Type I* the failure of descent is due primarily to the failure of development of the gubernaculum, and therefore to the failure of its guidance of a perfectly developed testis into its normal situation. This is in marked contrast to the poor development usually found in *Type II*.

Development of the Testis in the Inguinal Canal.—This question arises out of the foregoing remarks. That the testis can grow and develop on apparently normal lines in the canal is shown by the case quoted on p. 628. Here the right testis was noted at the operation to be normal in every respect to eye and touch, and only slightly smaller than on the unaffected side. The satisfactory development in this group also would support such a view, though the development is not so complete as in the scrotal position. This is well shown by *Case* 11 in *Type II*. On the right side (operated on) an apparently normal testis resulted seven years later, while the left testis, which descended to the neck of the scrotum in this seven years, was small and undeveloped.

Prognosis.—The outlook may be regarded with confidence in this group provided mobilization is adequate. The only poor result was in one instance when mobilization was not practised ; while on the other side, with adequate mobilization, a successful result followed operation.

Free division of the connective tissue of the cord is recommended by Southam and Cooper.[2] This in my experience is rarely called for—indeed. I prefer to have a little tension on the cord than carry out extensive manipulation at a young age, for such tension falls on connective tissues rather than on the slender vessels.

A successful result in this group is by no means to be regarded as easier of achievement than in *Type II* ; the cord may be very short and replacement difficult even when the testis is well developed. In two instances the testis, after extreme mobilization, could not be placed at the fundus of the scrotum except with considerable tension on the cord. In both cases the thigh was flexed, and gradually extended during the four or five subsequent days. The ultimate result was good in both instances. It would appear that, although tension is rare, a sharing of the connective tissue in the strain

protects the vessels to some extent; and that, by a gradual straightening of the thigh after, the circulation can accommodate itself gradually to the altered conditions.

Type II.—This embraces twenty-one operations; the average age was 8¼ years, and the results were perfect in 60 per cent and fair in 15 per cent— that is, satisfactory in 75 per cent. Of the three fair results, however, one was a secondary orchidopexy after a previous failure (*Case* 24). Excluding this last case, the two others were over 11 years of age.

Of the four poor results, mobilization was omitted in two. In one (*Case* 12) the side mobilized yielded a good result; but when this was omitted on the other side the operation was unsuccessful (*see Fig.* 379). *Case* 16 is another instance of the same kind (*see Fig.* 380).

Now it is significant that in this group most of the testes were poorly developed. The peritoneum of the sac was exceedingly friable, and the poor development of the cord and vas was in proportion. The whole picture, together with failure of descent, is one of developmental failure. This view, held originally by Hunter, and upheld by succeeding generations, may have to be modified.

It has been shown that a normally formed testis can develop approximately to the normal in the inguinal canal. There is evidence in this series that a certain degree of descent and development can take place naturally, but that the result is neither complete nor satisfactory. *Cases* 8, 9, and 11 are such examples. On the other hand, a testis felt in the inguinal canal *may disappear* in the course of years. In *Case* 19 the left testis (felt some years previously in the inguinal canal) could not be found; yet the result of operation was satisfactory on both sides. These observations seem to show that while some measure of development and descent can be hoped for by natural processes, a completely descended and normal testis cannot be hoped for; while the possibility of a disappearance of the testis high up into the inguinal canal must be reckoned with.

Since testes in this group have been shown to develop to all appearances in a normal manner after scrotal replacement by the method described, and in view of the foregoing remarks, failure of descent perhaps should be regarded rather as a *delayed development* at the time of birth than a *defect in* development. If this view is correct, some of the fair and poor results may well slowly develop to the normal in the course of time; and perhaps only atrophy after operation can be regarded as a failure. Atrophy occurred in 10 per cent of the series.

With regard to treatment of the sac in these cases, no attempt was made to dissect it away or to divide the connective tissue of the cord. In one instance (*Case* 23) scrotal replacement on both sides was only possible with considerable tension on the cord. On both occasions the thigh was flexed and only gradually extended. The result was good on both sides.

In the series there is one other case which is instructive—*Case* 20. This was an instance of operating on the hernia and leaving the testis *in situ*. Subsequent orchidopexy five years later yielded an indifferent result. At the same time orchidopexy in the infant is not likely to be successful (*Case* 18, operated on at 2¼ years: it is, however, possible that development may

proceed towards the normal in due course). On the whole it is probably wiser to make an effort to control the hernia by a truss (if necessary) until a suitable age for orchidopexy and the radical cure of the hernia at the same time.

CONCLUSIONS.

The following conclusions arise from a study of these cases :—

1. Imperfectly descended testes are to be classified into two groups: (a) *Ectopic*: Testis, tunica vaginalis, epididymis, vas, and cord well developed. No patent processus vaginalis. Descent alone imperfect owing to the failure of the scrotal portion of the gubernaculum. (b) *Imperfectly developed*: This group represents a retarded (rather than a defective) development capable of attaining the normal under suitable conditions. The development of all associated structures is rudimentary; and this, together with the imperfect descent of the testis, represents a general retardation of development of the parts concerned.

2. In both groups orchidopexy offers encouraging results provided adequate peritoneal mobilization forms an integral part of the procedure. The prognosis is best in the 'ectopic' variety. It follows that if on clinical examination an obvious hernial sac is present and the scrotum is undeveloped, the prognosis is not so good as when these features are absent.

3. The best age for operation is between 5 and 9 years. It is undesirable to perform orchidopexy much below the age of 5 unless it is necessary to cure an uncontrollable hernia.

4. It is useless to wait for complete natural descent and development. Though this result may in a measure be attained in the course of time, it is unlikely to be complete. Further, while a normal testis may develop to a fairly satisfactory degree in the inguinal canal, the true undescended testis will fail in this respect, and it may even ascend again to the internal ring.

5. If orchidopexy is performed without peritoneal mobilization, the testis will probably atrophy or be subsequently drawn up again into the inguinal canal.

6. Success or failure can only be estimated with certainty from six to nine months after operation. Accordingly, in double cryptorchids, it is advisable to wait about one year at least before operating on the second side.

7. There is no evidence in this series that testes brought into the scrotum are capable of spermatogenesis. On the other hand, the normal size, consistence, and sensation on examination (together with the normal development of the sexual characteristics in some of the older subjects) is hopeful. It is unlikely that testes apparently normal in every way should prove ultimately to be defective in this one respect.

In conclusion. I wish to express my thanks to Mr. George Gray and Mr. McNab for their help in tracing and collecting these cases; also to Mr. S. A. Sewell for his drawings.

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[2] SOUTHAM and COOPER, *Lancet*, 1927, 805.
[3] CUNNINGHAM, *Anatomy*.
[4] KEITH, SIR ARTHUR, *Human Embryology and Morphology*.

THE X-RAY DIAGNOSIS OF RIGHT PARADUODENAL HERNIA.

By JOHN TAYLOR,

ASSISTANT SURGEON AT THE ROYAL INFIRMARY, DUNDEE.

THERE is as yet no record that a case of right paraduodenal hernia has been diagnosed before operation. In 1906 Lord Moynihan wrote : " In a certain proportion of cases it is likely in the future that an operation will be undertaken after a correct diagnosis has been made."

Fig. 384.—Right paraduodenal hernia.

On April 3, 1926, a man of 32 years of age was admitted to the Dundee Royal Infirmary with a history suggesting chronic duodenal ulcer. He was operated on by my chief, Mr. John Anderson, who found that the whole of the jejunum-ileum, except the first and last three inches, was contained in a large right paraduodenal hernia. There was also a duodenal ulcer. On scrutinizing the X-ray films after operation one was struck by the bunched-like appearance of the small gut as if it were contained in a bag which prevented the various coils occupying any part of the peritoneal cavity (*Fig. 384*).

In January, 1927, a man of 24 years came up to my Out-patient Department with a history of pain coming on one hour after meals. This had been going on for four years and he was always worse in the forenoons. He relieved the pain by drinking water, but if he failed to do this the pain would last for an hour. He always felt as if he had eaten too much. He did not yield to medicinal treatment, and I had him X-rayed. The radiographer reported that the stomach was slightly prolapsed but definitely irritable. There was irregularity of the pyloric canal and much distortion of the duodenal cap. But the film (*Fig.* 385) appeared to me to be very similar to that of the
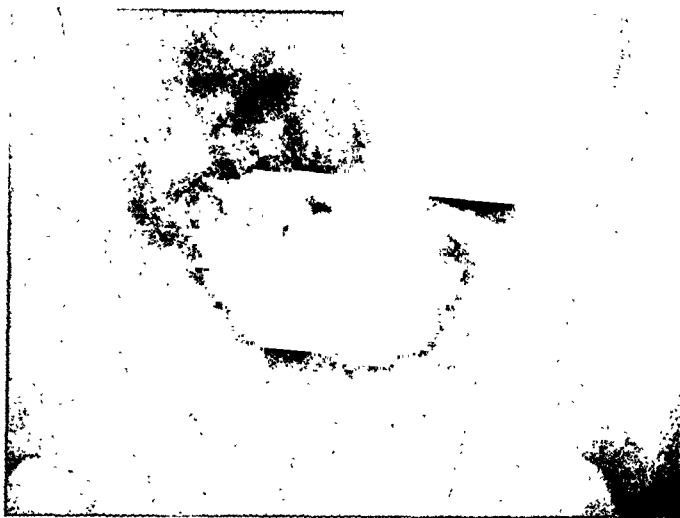
FIG. 385.—Right paraduodenal hernia diagnosed prior to operation from X-ray appearances. There was also a duodenal ulcer.

paraduodenal hernia shown in *Fig.* 384—there was the same suggestion of the small intestine being contained in a bag. I accordingly suggested that the condition was also one of right paraduodenal hernia, and my diagnosis was verified by Mr. John Anderson, who operated.

These two cases may be added to the 32 paraduodenal hernias collected by my colleague F. R. Brown,[1] bringing the total number of recoveries up to six, three being from Dundee.

REFERENCE.

[1] BROWN, F. R., *Brit. Jour. Surg.*, 1925, xiii, 367.

DIAPHYSECTOMY AND PRIMARY SUTURE FOR ACUTE OSTEOMYELITIS OF THE FIBULA.

By HAMILTON BAILEY,

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As far as the treatment of acute osteomyelitis is concerned, the fibula, by virtue of its anatomical and functional peculiarities, stands in a class by itself. It is for the fibula, and for the fibula alone, that diaphysectomy can be recommended unhesitatingly. The clean granulating wound which followed my first case of osteomyelitis of the fibula treated by this method emboldened me to try a primary suture on the next example to present itself. I have now carried out diaphysectomy with suture three times. The wounds have healed by first intention, and have remained healed—verily a surgical treat in a disease like acute osteomyelitis!

As I knew of a case where the external popliteal nerve had been divided in removing the diaphysis of the fibula. it came about that in *Case* 1. in the determination to ensure the integrity of this nerve, I left a piece of the upper end of the diaphysis behind.

FIG. 386.—*Case* 1. Sequestrum removed from sinus which developed over upper end of the incision.

Six months later a sequestrum was removed from the bottom of a sinus which developed over the upper end of the incision (*Fig.* 386). The following method, which is practically fool-proof, has been used in the remaining three cases with great rapidity and satisfaction.

After the application of a tourniquet to the thigh the shaft of the fibula is exposed through an ample incision, the peronei being retracted anteriorly. Using Doyen's raspatory. the periosteum is cleared and the whole of the diaphysis resected with Exner's shears. just as though it were a rib. The lower end is divided first. and whilst the

FIG. 387. *Case* 3. Condition of the wound three and a half weeks after operation.

upper end is being sectioned with the shears. Doyen's raspatory remains *in situ* around the extreme upper end of the bone. protecting the nerve. As soon as the shaft of the fibula has been removed its bed is swabbed out with

a watery solution of flavine, and the wound closed by interrupted sutures, except for a glove drain in its lower end.

FIG. 388.—*Case* 4. Condition of the wound on the fifteenth day after operation.

Case 1.—A girl, age 12, was admitted with acute osteomyelitis of the fibula. Diaphysectomy was performed and the wound packed with strip gauze soaked in flavine. When the gauze packing was finally removed a clean granulating wound presented, which slowly filled in. After the patient returned from the convalescent home a sinus developed over the upper end of the wound. Six months later a sequestrum (*Fig.* 386) was removed from the bottom of the sinus, after which the wound firmly healed. The cause of the sequestrum has been referred to above.

FIG. 389.—*Case* 3. Showing regeneration of the fibula after diaphysectomy: skiagram taken eight months after operation.

Case 2.—Violet G., age 7, had been attending another hospital with cellulitis of the leg for three days. On admission the child looked ill. The temperature was 102°, and there was tenderness over the whole course of the fibula. At operation the diaphysis of the fibula was found in a bath of pus limited by the periosteum. Treatment was carried out by the method indicated above. The upper three-quarters of the wound healed by first intention ; the remainder broke down somewhat, butf the whole wound was soundly healed in three weeks.

Case 3.—Marie E., age 6, for three days had pain in the left leg. The temperature was 99°. There was tenderness over both the tibia and the fibula, and there was some doubt as to which of these bones was the seat of the disease. It was elected to explore the fibula, and pus was found within its periosteum. Diaphysectomy was performed and the wound closed with the exception of a glove drain. *Fig.* 387 shows the condition three and a half weeks after operation.

Case 4.—William S., age 10, had been kicked in the calf six days previously. The temperature was 101° and there were typical signs of acute osteomyelitis of the fibula. The diaphysis of the fibula was resected and the wound closed with the exception of a small soft rubber tube in the lower end of the incision. The wound healed by first intention, and *Fig.* 388 shows the condition of the wound on the fifteenth day.

No permanent disability attends the removal of the shaft of the fibula. A light plaster case can be applied as soon as the wound has healed. but this is not essential. The shaft of the fibula slowly regenerates (*Fig.* 389). but long before this the patient is walking normally.

THE RADIUM PROBLEM.

III. THE TREATMENT OF CARCINOMA OF THE RECTUM WITH RADIUM.

By Sir CHARLES GORDON-WATSON,

SURGEON TO ST. BARTHOLOMEW'S HOSPITAL, LONDON.

WITH AN INTRODUCTION ON THE SPREAD OF CANCER OF THE RECTUM.

By CUTHBERT DUKES,

DIRECTOR OF THE RESEARCH LABORATORY AT ST. MARK'S HOSPITAL, LONDON.

THE SPREAD OF CANCER OF THE RECTUM.

THE possible paths of spread of cancer of the rectum are : (1) By direct extension through continuity of tissue on the surface and by infiltration into the rectal wall ; (2) By the lymphatic system ; (3) By the blood-stream. Though all these paths may be made use of in the dissemination of an advanced cancer, it must not be assumed that each path is equally available from the beginning of the disease. Extension through continuity of tissue is naturally the first method of spread, and as long as this is the only means of extension cancer remains a local disease, capable of eradication by local excision. From the point of view of radium treatment also, as long as the malignant growth is limited to the immediate region of its origin, satisfactory results may be expected from marginal radiation ; but as soon as vascular or lymphatic dissemination has commenced the surgeon is faced with a much more serious problem. A knowledge of the period in the development of cancer of the rectum at which venous or lymphatic spread is likely to begin would be a useful guide to treatment. This question is now considered in the light of recent pathological investigations.

THE SPREAD OF CANCER OF THE RECTUM THROUGH CONTINUITY OF TISSUE.

Cancer of the rectum commences as a proliferation of the columnar epithelium of the mucous membrane, and in its earliest stages takes the form of a mass of atypical epithelium growing in the mucous membrane and protruding to a greater or less extent into the lumen of the bowel. Thus, whether the malignant process begins in a previously level portion of mucous membrane, in a small patch of epithelial hyperplasia, or in a papilloma or adenoma, its first general architecture is that of a protruding epithelial mass. The amount of surface proliferation varies greatly in different cases and is dependent chiefly on the degree of deep infiltration of the rectal wall, which, as will be shown later, leads to a complete transformation in the general

contour of the growth. Meanwhile the surface growth enlarges by marginal increase, which tends to be greater in the transverse than in the longitudinal axis of the rectum, and its depth increases by infiltration of the rectal wall. The characteristic features of this deep infiltration are that the growth is more extensive in the submucosa than in the mucous membrane, resulting in an undermining of the mucous membrane at the edge, and that infiltration through the muscle coat takes place by root-like projections which push their way between the segments of the circular muscle. By the time the growth has reached the muscle it has commenced to ulcerate, usually opposite the point of deepest infiltration. The traditional classification of cancer of the rectum into protuberant and ulcerating types is misleading in so far as it suggests that these are different types of growth. Ulceration is due to interference with the surface blood-supply and to local sepsis. It commences at a predictable moment in the progressive evolution of the early protuberant tumour into the late excavated ulcer with raised edges.

No constant relationship exists between the extent of the surface growth of cancer of the rectum and the depth of extension by continuous infiltration. Protuberant malignant proliferations, almost completely surrounding the rectum, may be limited to the mucous and submucous coats, whereas a small ulcerating growth may have spread by deep roots extending into the perirectal tissues. The only generalization as to depth of spread which can be made from an unaided eye inspection is that tumours which project into the lumen of the rectum are not usually accompanied by much infiltration of the submucous and muscular coats, and that excavated ulcers with raised edges are usually associated with a spread by direct continuity into the perirectal tissues.
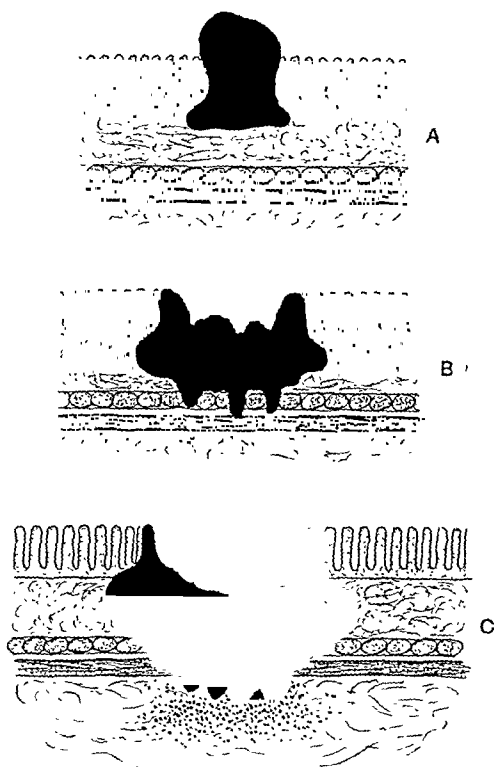
FIG. 390.—Diagram to illustrate classification of carcinoma of the rectum into A, B, and C cases according to depth of spread by direct continuity.

All cases of cancer of the rectum at St. Mark's Hospital are classified for the purpose of prognosis according to the depth of spread within the rectal wall. The system adopted is a modification of a clinical classification into A, B, and C cases (*Fig. 390*), suggested by Lockhart-Mummery[1]. A cases are malignant tumours in which the growth extends into the submucosa, but not into the muscle coat (*Fig. 391*). B cases are malignant tumours in which the growth extends into the muscle coat, but has not spread by direct continuity
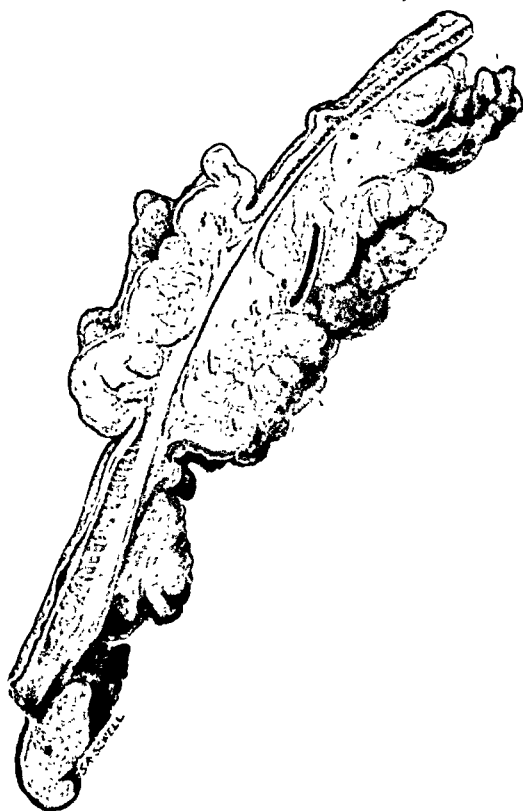
FIG. 391.—Carcinoma of the rectum, A case. Longitudinal slice of the wall of the rectum to show the general shape of a cancer which has spread only as far as the sub-mucosa.

FIG. 392.—Carcinoma of the rectum, B case. Longitudinal slice of the wall of the rectum showing commencing ulceration in the centre of the cancer opposite the point of maximum infiltration of the muscle wall.

FIG. 393.—Carcinoma of the rectum, early C case. Longitudinal slice of the wall of the rectum, showing the manner in which a malignant growth invades the muscle coat by means of roots which push their way between the segments of the circular muscle.

into the perirectal tissues (*Fig.* 392).   **C** cases are malignant tumours which have spread by direct continuity into the perirectal tissues (*Figs.* 393–395). **B** cases may be further subdivided into **B1** in which the circular muscle is the limit of growth, and **B2** in which the longitudinal muscle has been reached. **C** cases may also be subdivided into **C1** without glandular involvement, and **C2** with metastasis in the lymphatic glands. This classification is made after microscopic examination of big sections through the fixed and hardened tissue. It may be of interest
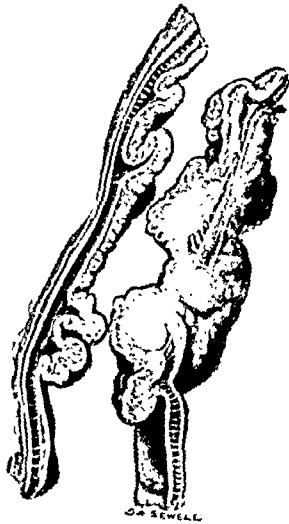
FIG. 394.—Carcinoma of the rectum, **C** case. Longitudinal slices through the walls of the rectum showing ulceration appearing *opposite to the point of maximum infiltration* of the wall of the bowel.

to remark that opinions expressed in advance, either before operation or immediately after removal of the tumour, usually err on the side of too favourable a prognosis.
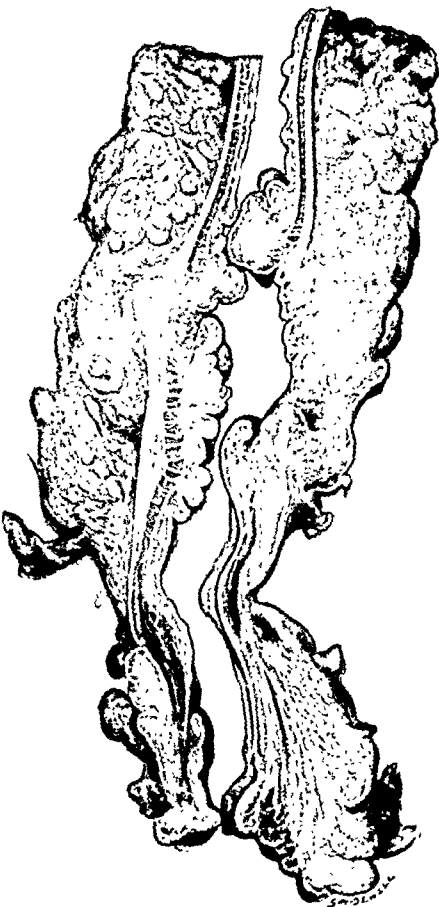
FIG. 395.—Carcinoma of the rectum, **C** case. Longitudinal slices through the wall of the rectum in an ulcerating carcinoma with metastases in glands accompanying hæmorrhoidal vessels.

Table I.—CLASSIFICATION OF RECTAL CANCER ACCORDING TO DEPTH OF SPREAD IN 100 CASES.

A cases	..	..	..	..	1
B ,,	..	..	..	..	24
C ,,	..	..	..	..	75
			Total ..	..	100

Of the B cases *12* were *B1*, and *12 B2*
Of the C ,, *35* ,, C1, and *40 C2*

Table I records the results of the application of this method of classification to the last 100 cases of cancer of the rectum operated on at St. Marks' Hospital.

THE SPREAD OF CANCER OF THE RECTUM BY THE LYMPHATIC SYSTEM.

The spread of cancer of the rectum through continuity of tissue is usually a slow process. Judging from clinical histories, several months may be occupied by the progressive extension through the rectal wall. It is important for the surgeon to know at what stage in this slow erosion of neighbouring tissue the much more rapid and far-reaching spread by lymphatics is likely to commence. Information on this point is supplied by recording the frequency of metastasis in the anorectal and retrorectal lymphatic glands in A, B, and C cases, as in *Table II*.

Table II.—PROPORTION OF GLANDULAR METASTASIS IN A, B, AND C CASES.

TYPE OF CASE	TOTAL	NUMBER WITH METASTASIS IN LYMPHATIC GLANDS
A	1	0
B	24	0
C	75	40

These striking figures seem to justify the conclusion that metastases do not form in the anorectal or retrorectal lymphatic glands until the cancer has spread by direct continuity into the perirectal tissues. On the present evidence, however, this must not be accepted as a rule without any possibility of exception, because the number of A and B cases which have been available for study is not large enough to permit an unqualified statement. Two other limitations in the methods used must be admitted. The material available for study consisted of the tissue removed by the operation of perineal excision, and it may be argued that lymphatic dissemination might have occurred to more distant glands without affecting those in the immediate neighbourhood of the growth. Again, it was not the practice to attempt to dissect out every gland attached to the excised rectum, the general routine being to remove for microscopic examination three or four lymphatic glands from the perirectal tissues round the growth, any enlarged and easily palpable glands from elsewhere, and a small piece of tissue including the superior hæmorrhoidal vessels. Experience showed that microscopic examination of these selected tissues was sufficient to settle the question of the presence or absence of glandular metastases, and it also provided many forcible reminders of the fact that enlarged and hard lymphatic glands do not necessarily contain cancerous metastases. The enlargement of the anorectal and retrorectal lymphatic glands in ulcerating cancers of the rectum is often due to inflammation, and the increased hardness to fibrosis.

In view of the limitations imposed by the method of investigation and the small number of A and B cases available for study, the figures recorded in *Table II* should be taken as an expression of what commonly occurs and not as the enunciation of an infallible rule. The facts may be expressed by

saying that spread to the anorectal and retrorectal lymphatic glands does not usually occur until the cancer has spread by direct continuity into the perirectal tissues.

Ernest Miles[2] has often stressed the importance of lateral and downward spread in addition to spread by the lymphatic glands accompanying the superior hæmorrhoidal vessels. In our series of 100 cases this was looked for by cutting the hardened tissue with a sharp knife and removing for microscopic examination any suspicious-looking plaques or glands. Evidence of lateral extension along the surface of the levator ani muscle was found in only one case, and downward extension across the ischiorectal fossa in three cases. These were all four C cases with metastases in the anorectal lymphatic glands, and in two of the cases of downward spread it appeared as if the cancer was spreading by direct continuity rather than by lymphatic channels. Once lymphatic dissemination has commenced, it may follow many different paths, as Semba has recently proved.[3]

THE SPREAD OF CANCER OF THE RECTUM BY THE BLOOD-STREAM.

We have no means of telling whether or not venous embolism occurred in any of these 100 cases. The possibility of vascular embolism introduces an unpredictable factor into all estimates in the prognosis of rectal cancer, but fortunately this accident is sufficiently rare not to upset calculations based on other factors. All that can be said about its frequency is that, on general principles, it is more likely to occur the longer the disease has lasted. It is more likely to occur also when the malignant process has spread deep in the bowel wall into the region of the larger veins—in other words it becomes progressively more possible as the disease advances through the A, B, and C categories.

CONCLUSIONS.

These observations on the spread of cancer of the rectum lead to the following conclusions of interest in relation to radium treatment :—

1. In three-quarters of the cases of cancer of the rectum accepted by surgeons as operable, the cancer has already spread by direct continuity into the perirectal tissues. These are classed as C cases.

2. In more than half of these C cases the anorectal or retrorectal lymphatic glands contain metastases.

3. Cancer of the rectum commences in the mucous membrane and extends slowly by direct extension through continuity of tissue on the surface and by infiltration of the rectal wall. As a rule lymphatic dissemination does not play any part in the spread of cancer of the rectum until the growth has spread by direct continuity into the perirectal tissues.

4. It is not possible to tell in advance whether the growth has spread only into the submucosa (A case). or into the muscle coat (B case). or into the perirectal tissues (C case). though it may be stated in general terms that A cases are freely movable and more so than B cases, and that C cases present varying degrees of fixation. The only generalization that can safely be made is that protuberant growths are more likely to be A or early B cases without lymphatic metastases. whereas excavated ulcers are more likely to be C cases with at least a 50 per cent probability of lymphatic spread.

THE TREATMENT OF CARCINOMA OF THE RECTUM WITH RADIUM.

(SIR CHARLES GORDON-WATSON.)

If the results of the investigations which Dr. Dukes has made in 100 excised rectums are confirmed in a larger series of cases, and if a case can be safely diagnosed as A or B (and therefore presumably free from lymphatic spread), it seems evident that the present practice of radical excision with colostomy for all such cases may in the future be regarded as unnecessary : and that a local resection may again be looked upon as a sound surgical procedure, with as good a prospect of cure as more radical measures. Though a good case can be made out for the use of radium in preference to radical excision in a small and easily accessible growth, it is doubtful if, at the present time, the employment of radium could be advocated in preference to a simple local resection except in those instances in which operation is refused. Two cases of this nature treated with radium in which operation was refused have now been under observation for over a year. These patients have escaped colostomy and remain well.

There are, however, cases of the A or B type which are situated so near the anal margin that even a local resection demands a preliminary colostomy. In these cases an adequate attack with radium without barrage of the lymphatic areas and without colostomy might well be justified : if radiation proved unsuccessful, a surgical cure would still be possible.

It is not often that a carcinoma of the pelvic portion of the rectum— that is, above the peritoneal reflection—comes into the surgeon's hands in the A or B stage. Any operation for a growth in this situation, short of a radical excision with colostomy, is fraught with considerable surgical difficulty and risk. In this type of case the employment of radium should be considered, and if the general condition of the patient is at all unfavourable to radical operation, should certainly be given a trial.

Unfortunately histological evidence from the excised rectum does not enable the surgeon to classify his advanced cases into C1 and C2, but it is certain that a fixed and ulcerating growth belongs to the C class, and, if firmly fixed and clinically advanced, that it belongs to C2. It becomes obvious that in this class any attempt at radical radiation must include an efficient barrage of the lymphatic areas. In this connection it is important to note that Dukes' results indicate that the upward line of spread, along the superior hæmorrhoidals, is of paramount importance, and the middle and inferior hæmorrhoidal areas of minor importance, except when the anal canal is involved. Further, it is clear that any attempt at radical treatment must include a laparotomy, and investigation of the liver and the pelvic lymph-glands, which if involved can be attacked from above (*see below*) more efficiently than from below.

If secondary deposits have reached the lymphatic glands at the brim of the pelvis, it is obvious that the case is not far from hopeless. Nevertheless I have frequently proved that enlarged glands in the mesorectum are inflammatory and not malignant, and it is comparatively easy, especially with seeds, to barrage the inferior mesenteric lymph-track along its whole length.

RECTAL RADIUM THERAPY.

Although radium has been employed in the treatment of cancer of the rectum in this country for thirty years or so, it is only within the last five years that we have attempted to treat the disease by a combination of surgery and radiation, and our present knowledge of the effects of radiation does not
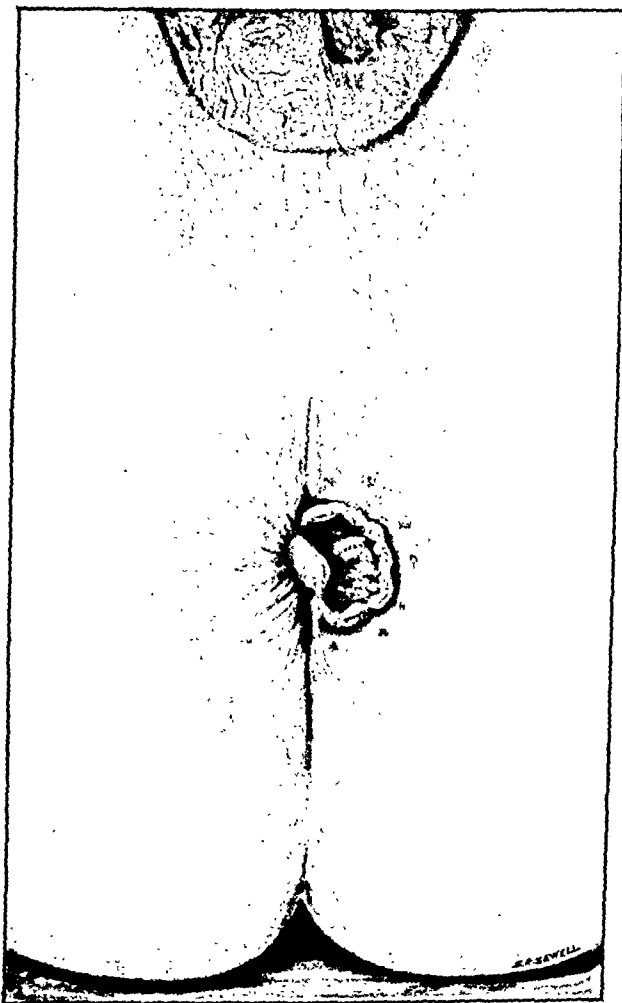
FIG. 396.—Epithelioma of anus treated with needles.   (*Mr. Milligan's case.*)

allow accurate deductions to be made as to the changes which may be expected to follow a given type or degree of radiation.

Tissue response to radium depends upon several varying factors about which at the present time we have little knowledge. We know that the more specialized the malignant cell, the more radio-resistant it is; and the more the type conforms to embryonic tissue, the more radio-sensitive it is.

Adenocarcinoma of the rectum has in the past been generally regarded as very radio-resistant. My experience of the last five years leads me to believe that this impression has arisen in part from the difficulty of access, as compared with the cervix uteri, the tongue, and the breast, and that when a uniform and complete barrage of the growth is possible, results are often
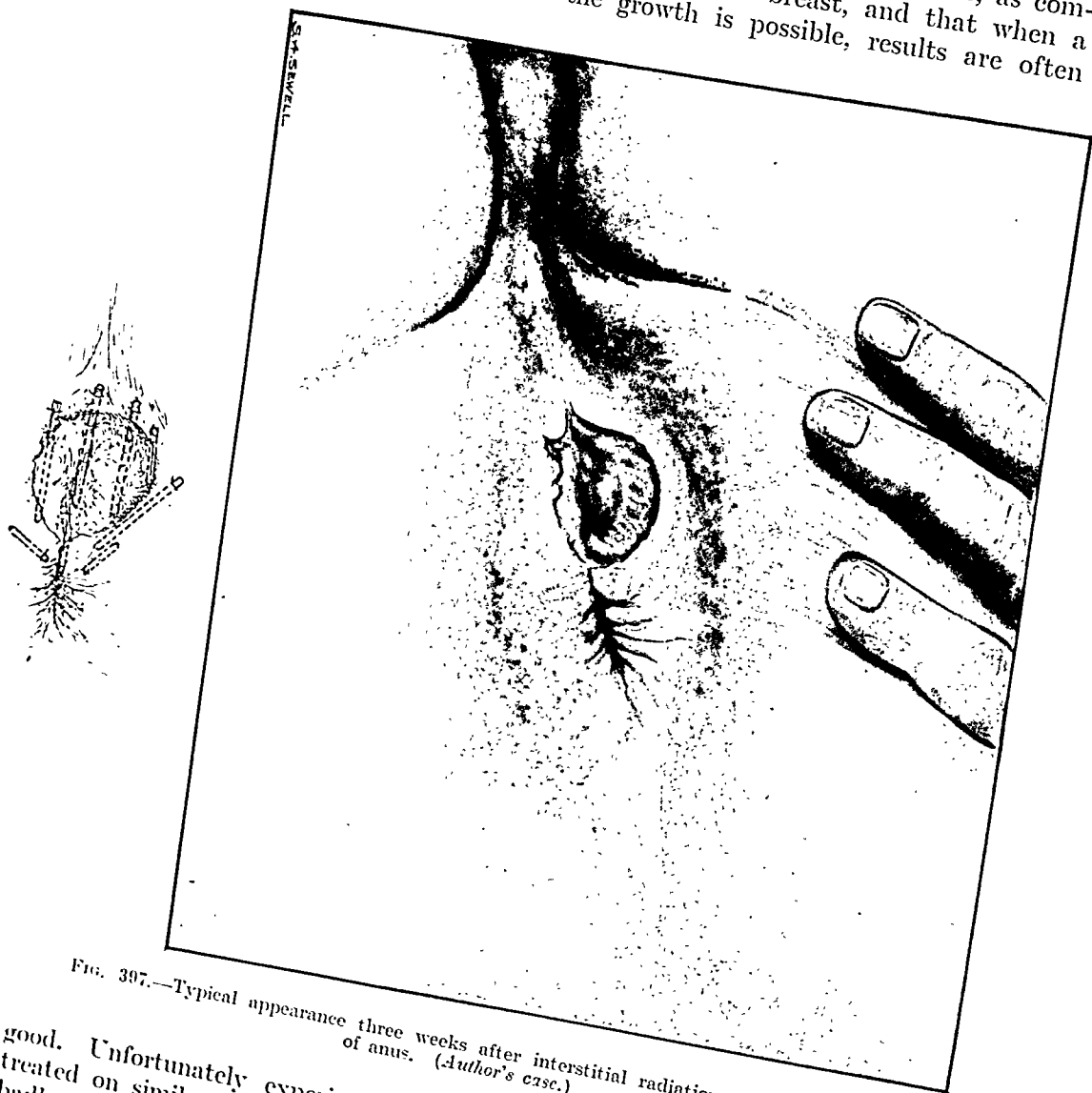
Fig. 397.—Typical appearance three weeks after interstitial radiation of epithelioma of anus. (*Author's case.*)

good. Unfortunately experience shows that two apparently similar cases treated on similar lines may respond in one instance well and in the other badly.

With the help of surgery a fair proportion of advanced low rectal carcinomas can be exposed from behind and mobilized in such a way as to give access to all parts of the tumour so that a uniform barrage can be secured. Further, high growths which extend above the peritoneal reflexion can be

dealt with successfully, though with greater risk, by approach through the peritoneal cavity. Squamous-celled carcinoma involving the anal canal and perineal skin can be relied on to respond to radium with far more certainty than columnar-celled carcinoma, and if seen in the early stages can be cured without resort to colostomy (*Figs.* 396–399).
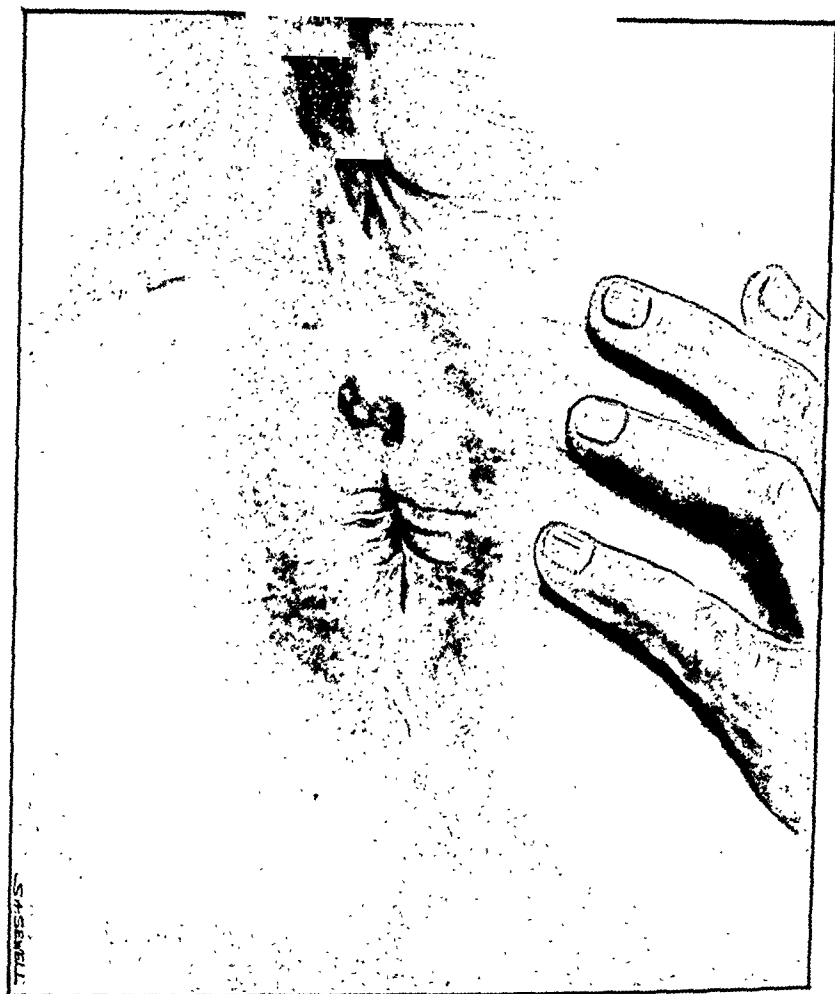
Fig. 398.—Same case as shown in *Fig.* 397, a fortnight later.

During the past five years the author has treated over 90 cases of cancer of the rectum with radium, and the majority of these have been regarded as inoperable. In the past those cases considered unsuitable for excision have in most instances been submitted to colostomy, to prolong life without hope of cure. Many of these inoperable cases are now available for radium treatment combined with colostomy, and experience shows that. in addition to the benefit secured by colostomy. they are afforded some prospect of cure. While it is impossible to be dogmatic at the present time, it may be affirmed

with some confidence that radium should be employed for the *fixed inoperable growth* if reasonably accessible to radiation, and if no visceral metastasis is discovered.

In *borderline cases* the general operative risks must be assessed. For example, most surgeons hesitate to advise excision in stout elderly patients with a tendency to bronchitis, and regard the male with more fear than the
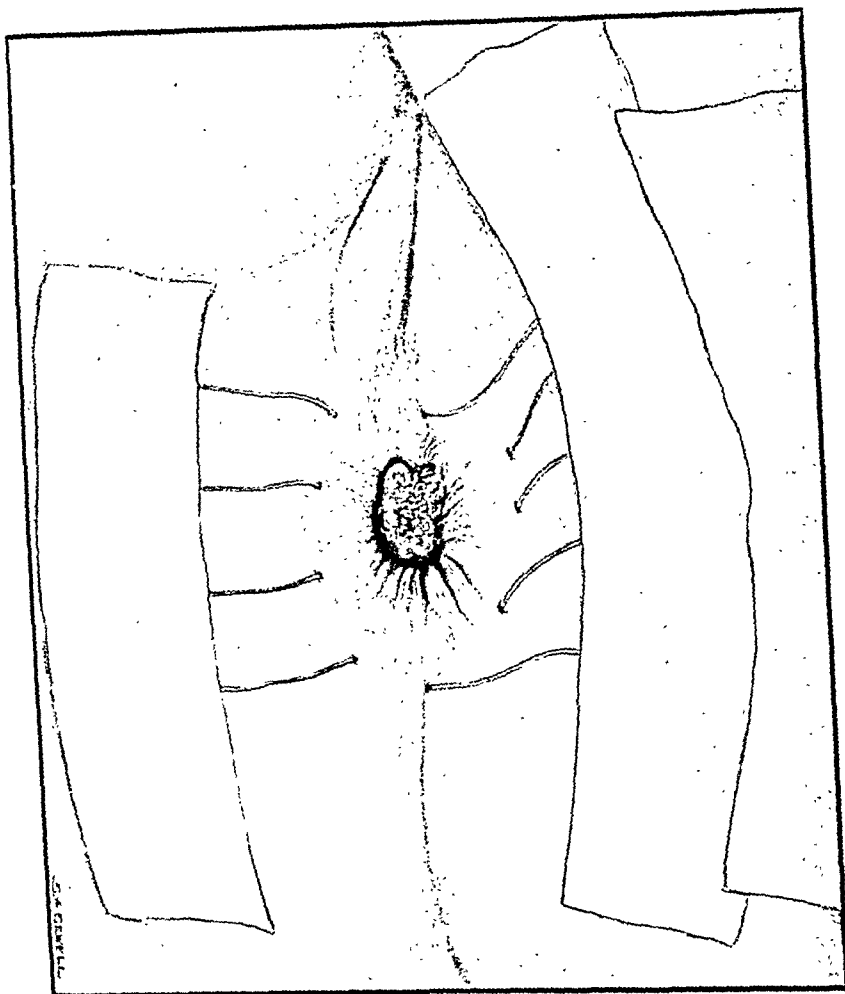
Fig. 399.—Perirectal radiation for epithelioma of the anus.

female : in such cases the alternative of irradiation is welcomed. The local conditions which favour excision rather than radium must be balanced up with the general. For example, a growth which involves the anterior wall of the perineal portion of the rectum in the male with some fixation is not very accessible to uniform radium implantation, and local conditions are more favourable to excision. On the other hand, a growth involving the pelvic portion of the rectum is accessible to abdominal radiation, and excision may only be possible by the abdomino-perineal route. In the latter case the

increased operative risks may strengthen the arguments in favour of radium treatment, especially if the age and general condition of the patient are regarded as unfavourable for radical surgery.

At the present time, in the author's experience, the results of irradiation of *operable growths* are for the most part too recent to justify an expression of opinion in favour of radium in preference to operation. There is no doubt that when radical excision is refused, or contra-indicated on grounds of general health, radium offers a promising alternative, and it may be stated definitely that when the growth is small and accessible, successful irradiation can be secured without the stigma of a colostomy. It is not yet possible to review results and assert that rectal irradiation of an early growth offers as good a hope of permanent cure as radical surgical excision.

RADIATION TECHNIQUE.

Given an accessible primary growth, the key to successful radiation in any individual case lies in the correct assessment of the amount of radium required, the method of distribution, the time it should be left in, the amount of filtration required to secure a pure γ radiation, the prevention of sepsis or necrosis from β radiation or excessive γ radiation, and the protection of adjacent healthy tissues. Further, if surgical radiation is to be completely successful. a healed wound with restoration of function, without serious deformity. must be added to the assessment. In other words, all these factors have to be determined to assess and secure the *optimum* dose. To arrive at an optimum dose in any individual case is the outstanding problem which besets all radium workers, a problem which can only be solved as the volume of experience grows. An incorrect assessment, whether of the amount of radium, of the time, of the filtration, or of the distribution, spells failure. Other factors come into play which influence the dose, such as excessive vascularity or excessive fibrosis, proliferation or ulceration, rapid or slow growth, and doubtless other, as yet unknown, biological factors which may increase or diminish radio-sensitivity and have a material bearing on the detail of radiation.

With these obstacles to face in the attack on the primary growth, there still remains the second line of defence—the line of lymphatic spread—to overcome, one that is often held by an invisible host.

Enough has been said to indicate that surgical radiotherapy demands intensive case study, and years of constant practical application to the subject. to ensure a fair measure of such success as is possible. The time is not yet ripe when the measure of possible success can be computed.

In the early days of rectal radium therapy tubes containing 50 mgrm. of radium or more were inserted into the lumen of the rectum. and repeated for short periods of about twenty-four hours at a time. and though in some instances cures were recorded. in the majority only the surface area of the growth was destroyed by radio-necrosis and little permanent benefit ensued. Frequently severe radium burns followed this method. resulting in great pain and distress to the patient. Such results as these were inevitable. having regard to the irregular contour of most rectal growths and the mechanical impossibility of accurate and uniform radiation to all parts of the growth by

means of a central tube, and bearing in mind the important fact that the intensity of radiation varies inversely as the square of the distance.

A new chapter on rectal radium therapy was opened when in 1924 Neumann and Coryn, of Brussels, described a method of interstitial radiation with needles after surgical exposure of the growth from the perineum. The author paid a visit to Neumann's Clinic early in 1925, and with the aid of radium supplied by the Medical Research Council commenced research on the lines of the Brussels Clinic. During the first two years of this research a limited number of advanced inoperable cases were attacked. After a preliminary colostomy the rectum was exposed from behind after removal of the coccyx and separation of the levatores ani. The growth was mobilized as far as possible to enable needles to be inserted to all parts of the growth. In the female the anterior portion of the growth was attacked through the posterior vaginal wall (*see Fig.* 405). Needles were passed along the lines of lymphatic spread upwards, laterally, and downwards in the course of the hæmorrhoidal vessels. The full details of the operation have been described elsewhere.[4] Subsequently inoperable growths above the peritoneal reflection were attacked through the abdomen, at first with needles and later with radon seeds.

During the last two years a certain number of operable growths have been radiated; a few early **A** cases by intrarectal puncture with seeds, and others of the **B** or early **C** type by open perineal or vaginal needle puncture without colostomy. The technique in inoperable cases has been further developed by combined intra-abdominal and perineal (or vaginal) attack, and also by intrarectal radon seed implantation combined with perirectal radium needle puncture through the skin, in cases in which either on general grounds or because of local difficulties an open operation has been considered inadvisable.

Filtration.—The filtration employed has been 0·5, 0·6, and 0·8 mm. of platinum. It is desirable to avoid all risk of β radiation within the peritoneum, and a filtration of 0·8 which cuts out all primary β rays seems desirable and is now being used when available. When a considerable amount of radium is implanted into a rectal growth below the peritoneum, it is probable that better results will be secured with the same filtration (0·8), but in any case 0·6 mm. platinum eliminates 99·9 per cent of the β rays and is preferred to 0·5.

Needles.—In order to secure uniform radiation it is desirable that the needles employed in any one case should all be of the same linear intensity— for example, 1 mgrm. per 1·6 cm. of active length. For rectal work it is advisable to employ needles of varying length. Long needles (active length 4·8 cm.) passed along the lines of lymphatic spread, containing 3 mgrm. each, are very useful, and needles containing 2, 1·5, 1, and 0·5 mgrm. of the same linear intensity (1·6 cm. per 1 mgrm.) should be used in order to secure a uniform and complete barrage of a growth—which may vary considerably in thickness and present considerable irregularity at the margins. As far as possible the needles are inserted parallel to one another and the periphery of the growth encircled. An attempt is made to deliver 1 mgrm. of radium to each cubic centimetre of growth. (*Fig.* 400.)

The Time Factor.—There is still some difference of opinion among radium workers with regard to the use of heavy doses for a short period, or

smaller doses for a longer period.   The radio-sensitivity of cellular tissue is known to vary considerably according to its nature—for example, columnar-celled carcinoma is more radio-resistant than squamous-celled carcinoma, lymphosarcoma far more radio-sensitive than any carcinoma, and a rapidly growing tumour is more sensitive than one that grows slowly.   The stages of development of a cell, whether actively secreting, in mitosis, or at rest, are factors which have to be considered.   Experimental work shows that tissues which are most active in mitosis are most susceptible to radium, and further that mitosis is inhibited soon after the application of radium, though it returns about four days later in disordered fashion and is soon followed by cell disintegration.   Experimental work seems to indicate that the period of time

FIG. 400.—Radiogram showing posterior barrage with needles.

required to inhibit and disintegrate a number of cells in different stages of activity (given an adequate dose) is not less than about seven days.   Ten days has been adopted by the author as the approximate standard of time for rectal radiation, though shorter periods are adopted within the abdomen (five to eight days) owing to the great susceptibility of the peritoneum to irritation.

Biopsy.—Whenever considered desirable a portion of growth is removed for section.   In the earlier cases this was done at the time of the colostomy operation by means of a special punch.   In later cases a portion has been removed at the same time as the needles.   By the latter method there is less likelihood of stimulating metastasis.   When early growths have been dealt with it has been considered inadvisable to disturb the growth for the purpose of biopsy.

INDICATIONS FOR RADIUM.

The following advantages can be secured by the use of radium appropriately applied in adequate dosage :—

1. In cases too advanced for radical surgery : (*a*) A few cases will respond so well that the growth can be destroyed and a cure result. (*b*) The growth in some instances can be reduced in size and rendered sufficiently mobile to permit of excision. (*c*) In the most advanced cases pain can be relieved, hæmorrhage checked, and excessive secretion reduced. (*d*) Local recurrences following excision, and secondary glands in the groin, can be completely destroyed. (*e*) Radium may be employed as a secondary measure to deep X-ray therapy in cases too advanced to attempt radical treatment with radium by open operation. Preliminary treatment by deep X-ray therapy has in one case produced improvement so that radium treatment became possible.

2. In cases considered suitable for radical operation but in which a radical operation is contra-indicated on other grounds, or is refused by the patient, radium offers high hopes of a cure.

3. In cases favourable for radical operation : such excellent results have been secured in a limited number of cases as to justify the employment of radium in operable cases when the patient is averse to a major operation, or when the general state of the patient's health is such as to increase the risks. In some a successful result has been secured without a colostomy, which is essential to sound radical surgery. No operable case treated with apparent success in this way has been under observation long enough to express an opinion as to the chance of recurrence, though several have continued well up to two years. On the other hand, some of these growths have not responded as expected and excision has been carried out after radiation.

METHODS OF ATTACK.

The following methods have been adopted by the author for radiation of rectal carcinomas, separately or in combination: (1) Barrage by *open operation* from the perineum with needles after preliminary colostomy ; (2) Intra-abdominal radiation with needles or seeds ; (3) Radiation through the vagina ; (4) Intrarectal radiation with needles or seeds ; (5) Radiation through the perineal skin ; (6) Surface radiation (on Columbia paste). Up to the present it has not been possible to employ distant 'bomb' therapy. A certain number of cases have been treated by deep X rays prior to radium, and a few by X rays after radium.* In all the earlier cases a preliminary colostomy was insisted on. During the past year or so a number of cases of the operable class have been dealt with without colostomy, and some of them successfully up to date.

The Open Perineal Operation (Posterior Barrage).—The technique of the perineal operation consists, in brief, of removal of the coccyx, division of the

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* Douglas Quick, of New York, has employed 'bomb' therapy in a large series of cases, with some excellent results, as a preliminary to interstitial therapy.

median raphé at the junction of the levatores ani, and free exposure of the ampulla of the rectum (*Fig.* 401). The lines of lymphatic spread along the superior, middle, and inferior hæmorrhoidal arteries are then barraged, and subsequently the growth is uniformly needled so that all parts of the growth, especially the periphery, receive as far as possible uniform radiation of not less than 1 mgrm. per c.c. In the female the anterior portion of the growth is barraged through the posterior vaginal wall. The time factor is usually ten days, and from 30 to 60 mgrm. of radium are employed according to the size and extent of the growth. The wound is packed with flavine gauze and kept moist by the Carrel-Dakin method, the skin wound being temporarily closed until the radium is removed. The wound is slow to heal and usually takes about six weeks to close. The primary reaction is usually slight, but sometimes in feeble individuals radiation is followed by extreme weakness, loss of appetite, and occasional vomiting—a group of symptoms, however, which has never proved fatal.

FIG. 401.—Interstitial radiation by the posterior barrage method for an annular growth.

Very little change can be noted in the size of the growth under four to six weeks, and the most marked change occurs in the third month; but usually after a short period of increased secretion of mucus, unless an overdose has been given, the local symptoms are relieved and hæmorrhage and tenesmus are checked. The most striking feature in these cases is, that as soon as the immediate effects of the operation and radiation are passed, the general condition of the patient improves rapidly, and even when no diminution can be noted in the size of the growth, the patient recognizes that his condition has improved enormously.

In the case of a growth which has ulcerated deeply, perforation may result during the stage of separation of the rectum from the parietes, and sepsis, which is not easy to control, may inhibit effective radiation and seriously prolong convalescence. If this complication seems probable, the perineal operation should be avoided and an attempt be made with intrarectal seeds, fortified by perirectal needles passed through the perineal skin. *If the operation has been undertaken and fixation is extreme, puncture should be made through the levators to avoid risk of perforation in separating them from the growth.* In some instances of a similar type perforation follows soon after radium puncture, with the disadvantages already mentioned. Nevertheless, if the radiation has been adequate these cases will heal. In one instance of this nature, operated on without colostomy, perforation occurred and a severe and fatal sepsis followed.

If advanced inoperable growths are treated on palliative lines, care must be exercised when the growth involves the base of the bladder. Too intensive radiation on this situation has precipitated perforation into the bladder. In such cases radiation should only be employed when pain,

tenesmus, or hæmorrhage makes the patient miserable. Perforation into the ischiorectal fossa, with secondary suppuration, is a definite contra-indication to radium.

Experience shows that whenever deep ulceration is present the needles should be confined to the periphery of the growth and the non-ulcerated areas of the growth, and the dose should err on the light side.

Adenocarcinoma, though resistant, is not insensitive to radiation, and large doses are required; but an overdose usually results in radio-necrosis and consequent sepsis even though the β rays are practically eliminated with adequate filtration. Herein lies one of the great difficulties in dealing with the large inoperable growth, and it will be many years before experience will determine the optimum dose in any given case.

If a small tumour is adequately treated and responds favourably, either the growth will be destroyed and repair take place without appreciable deformity (an optimum dose); or a cicatrix will form which will be followed by the gradual formation of stricture which, unless controlled, will end in stenosis (an excessive dose); or the growth will retrogress almost entirely but not completely, and subsequently show increased activity (an inadequate dose); or there may be practically no response (a radio-resistant tumour). In the case of large growths it seems necessary to push radiation to the full extent so that cicatricial contraction follows and ultimately stricture and stenosis, and this means that for the large inoperable growth colostomy is essential, quite apart from the necessity of examining the liver and the pelvic lymph-glands and attacking the latter from above if thought wise.

It is therefore evident that it is extremely difficult to hit the happy medium between a full dose and an overdose. It might be argued that it would be wiser not to risk a full dose and to be prepared to repeat radiation if necessary. Unfortunately, primary radiation tends to produce an increased degree of radio-resistance, and this method cannot be advocated. Rectal radiation is followed by a considerable degree of perirectal fibrosis, which diminishes the blood-supply to the part and tends to render subsequent irradiation ineffective, apart from any immunity (if such occurs) which the cancer cells may have acquired.

It is important to recognize the perirectal fibrosis which occurs as a part of the radiation process, otherwise an inexperienced worker might mistake it for extension of growth. In a case which progresses favourably this nodular fibrosis gradually diminishes and finally disappears, though the end-result may be complete rectal stenosis. In the post-operative treatment, regular three-hourly instillation of flavine (1–1000) through the catheters inserted into the wound at the time of operation must be insisted on, and after removal of the radium strict Carrel-Dakin treatment is carried out. When the wound starts to heal, ultra-violet light hastens the process, which may be assisted by a dressing of 1 per cent radiostol in paraffin. Cystitis is a common complication, but can usually be avoided or rendered harmless by the method which Dukes has advocated for excisions.[5]

The following case is a good example of a posterior barrage followed by apparent cure. The case is particularly striking in view of the age of the patient.

Case 1.—Female, age 39. Inoperable fixed annular carcinoma commencing 5 cm. from the anal margin ; the upper limit was not defined. Preliminary colostomy was followed by posterior barrage (April, 1926). Thirty needles containing 38 mgrm. radium were left in position for seven days ; two needles, each 5 mgrm. were inserted through the posterior vaginal fornix for seventy-two hours : total dose, 7104 mgrm.-hours. The growth retrogressed and a fibrous stricture followed. The patient remains well and free from evidence of growth (now four years since radiation).

Abdominal Radiation.—Whenever it is decided to treat an inoperable case of carcinoma with radium the abdomen should be opened and the liver

FIG 402.—Radiogram showing abdominal radiation with seeds to growth and glands.

examined. If there is no evidence of hepatic metastasis, the growth is examined from above, and the mesorectum, mesosigmoid, and iliac regions are explored for lymphatic enlargement. If the growth is partly or entirely above the peritoneal reflection, effective radiation from below is either impossible or both difficult and dangerous.

Many of these cases have been dealt with by radium-puncture with needles or seeds (*Fig.* 402). When the growth is situated entirely above the peritoneum seeds present many advantages. They can be buried in the substance of the growth in a uniform manner with less risk of intestinal leakage, and into the mesentery behind and above the growth. The efficiency of the

radiation depends on the extent of the growth and the presence of adhesions. It may be fairly easy to define the limits of the growth and to secure a uniform barrage, or it may be impossible to define the growth accurately and to be sure that the malignant area has been encircled, or to avoid puncture of the lumen. The amount of radium employed has varied considerably according to the size of the growth. The milligramme-hour dose has varied from about 2500 in small to about 6500 in large growths. Needles are left in from five to eight days and the radon seeds are left permanently *in situ*. The first stage of the colostomy is carried out at the conclusion of the radiation.

It is not essential to drain the peritoneum when seeds are employed; most of the cases have not been drained. If needles are employed drainage is essential and packing-off of the radiated area advisable. The strings attached to the needles are brought up to the abdominal wall,
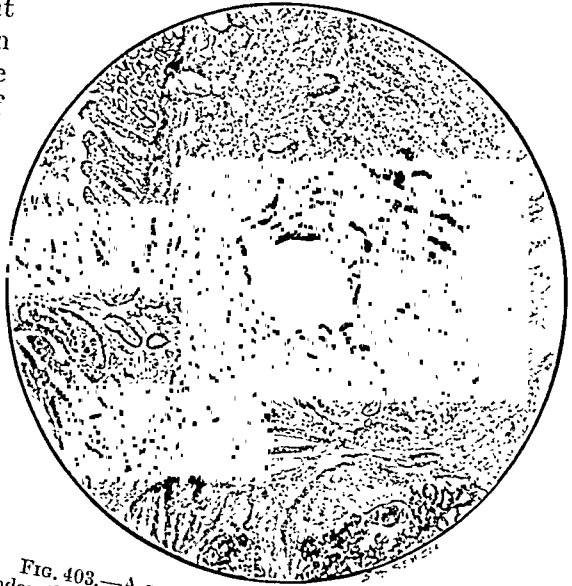
FIG. 403.—A specimen of carcinoma of the rectum under the care of a colleague removed post mortem after abdominal radiation. The necrotic space in the middle of the specimen is a needle track. This track communicated with the lumen of the rectum and the peritoneal cavity. Death was due to peritonitis.

but buried beneath the skin. When needles are employed it is advisable if possible to delay opening the colostomy until after their removal from five to eight days later. When seeds are used the colostomy can be opened whenever necessary.

FIG. 404.—Abdominal radiation with needles, a and b, alternative method of using needles within the abdomen.

The employment of needles in supraperitoneal growths is a more formidable, but probably a more efficient, procedure. Great care is required to avoid puncture of the lumen of the bowel and establishing a track between the peritoneal cavity and bowel—a track which soon becomes enlarged by radio-necrosis (*Fig.* 403). In one instance a fatal peritonitis resulted from this cause. It is desirable to insert the needles in the long axis of the bowel, and not at right angles to it, and for this purpose it is necessary to be provided with needles of varying lengths which contain approximately the same amount of radium per centimetre of active length. *Fig.* 404. b shows one method of avoiding penetration of the lumen.

In other instances when puncture of the growth seems dangerous the needles can be stitched to the surface of the growth and the whole area covered with rubber tissue (*Fig.* 404, *a*).

The great disadvantage of the use of needles is the fact that they require to be removed, and that they entail a risk of peritonitis. The needles are inserted with the patient in the Trendelenburg position; the same position should also be adopted when they are pulled out. As a general rule they come away readily when the strings are pulled on, but occasionally it is both necessary and advisable to reopen the abdomen. In view of the fact that the radium sets up a mild peritonitis and results in a discharging sinus, the latter procedure is not without risk. At the present time the author employs rubber sheeting with Coffey's gauze-wick drains to pack off the radiated areas until the needles are removed, in order to avoid risks from leakage and the danger of adhesions to the small gut. If it can be shown that radiation with seeds can be made as efficient as with needles, there is no question that seeds should be preferred.

Ar the present time, in the author's experience, the best results with abdominal radiation have been secured with needles, which is no doubt due to the constant intensity as opposed to the diminishing intensity of the emanation. At the end of four days radon loses half its strength, and unless it is reinforced at this period there is a danger that the growth will be inhibited rather than destroyed. Immediate results with seeds have been promising at first, but have been incomplete or the patient has relapsed. No serious complication or fatal case, however, has followed intra-abdominal radiation of a tumour with seeds. When the growth is partly above and partly below the peritoneum the lower edge is dealt with by introducing seeds via the rectum. This may be carried out at the same sitting if seeds are used within the abdomen, but if needles have been employed it is advisable to wait until after their removal, as the lithotomy position required for intrarectal seeding may disturb the position of the needles.

The following case is the best result secured by abdominal radiation with needles :—

Case 2.—A postman, age 44, was admitted with an annular growth at the junction of pelvic and perineal portions of the rectum, which was fixed to the base of the bladder and to the sacrum. The abdomen was opened and the growth barraged with nine needles containing a total of 20·5 mgrm. left in position for 115 hours (2357 mgrm.-hrs.). The pelvic colon was fixed outside the abdomen in preparation for colostomy. The patient, however, with a liberal supply of paraffin, continued to evacuate his motions with comfort per anum after the radium was removed, so that the opening of the colostomy was postponed and in the end was never carried out. No replacement operation was performed, and the skin closed over spontaneously. The patient returned to work soon after discharge from hospital and has remained in uninterrupted good health since (now over two years).

Sigmoidoscopy shows a narrowed lumen, but no evidence of growth. The bowels act normally and regularly. The site of the original colostomy wound shows no evidence of hernia.

Vaginal Radiation.—As already stated, this route is made use of for growths which involve the anterior wall of the perineal portion of the rectum. in combination with exposure from behind and a posterior barrage, or with

abdominal radiation. The method may be employed by itself for an early anterior growth or be combined with intrarectal seeds, or in more advanced cases it may be combined with needling of the retrorectal space without exposure of the rectum (*Fig.* 405). This method is also of value as a palliative measure in advanced cases unsuited for surgical procedures. In one instance a rectovaginal fistula healed by this method and retrogression of the tumour made an excision possible and successful. In another case a rectovaginal fistula with recurrence of growth followed a local resection which had been carried out in the provinces. This was treated by vaginal radiation; the fistula closed and the recurrence cleared up, but three months later growth appeared above the original site of recurrence. Excision was carried out successfully. If a heavy dose of radium is employed through the vagina, it is advisable to

FIG. 405.—Vaginal radiation with perineal glandular barrage.

protect the anterior wall with rubbered lead or a gauze pack, but in most instances this is unnecessary as it is difficult to burn the vaginal mucosa.

Intrarectal and Perirectal Radiation.—Three main routes of attack, from above, behind, and in front, have been described, and these may be regarded as the methods of choice. Direct attack via the lumen of the rectum has certain disadvantages unless the growth is quite small, when, as already stated, it may be possible to wipe out the growth without a colostomy and without subsequent disability. In a large growth access is difficult, uniform barrage almost impossible, and the lymphatic spread is not dealt with.

The poor results obtained with a central tube have been referred to. It is difficult to keep needles in position in the growth for an effective period. Hæmorrhage, sepsis, and risk of metastasis are necessary evils of the method.

If intrarectal treatment is considered advisable, seeds should be used. The author employs this method in certain early cases in which operation is refused or contra-indicated, in advanced cases when there is little hope of cure, for relief of troublesome symptoms, and as an accessory treatment to abdominal, perineal, or vaginal radiation. In an annular growth treated on palliative lines the seed introducer is passed deep to the growth to its upper limit and a seed introduced. The introducer is withdrawn 2 cm. and another seed introduced, and so on according to the length of the growth. For a uniform annular growth this is repeated round the clock at 2, 4, 6, 8, 10, and 12. Seeds of 1·5 mc. to 2·0 mc. (0·5 mm. filtration) are usually employed. A uniform annular growth involving 6 cm. of the ampulla of the rectum would thus receive 18 seeds.

It will depend on the position of the tumour whether the seeds are passed through puncture holes in the skin round the anus and directed by a finger in the rectum to the deep surface of the growth, or are passed through the lumen. The former is preferable, and suitable when the growth is low. If the growth involves the upper portion of the ampulla, the method just described is more easily carried out. In some cases intrarectal seeds have been

combined with needles passed through the skin into the perirectal tissues; this is advisable if an attempt is made to cure the case by this method (*see Fig.* 399).
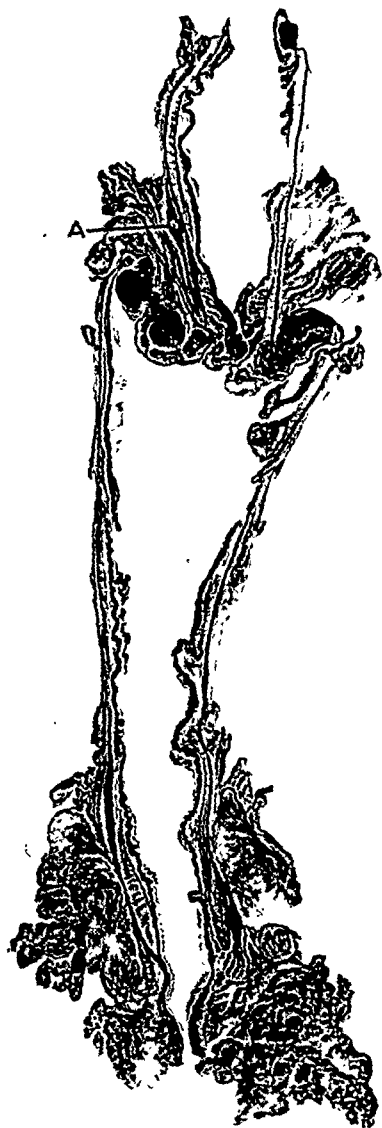
In anal carcinoma a combination of needles round the growth, and seeds into it, has been very successful. When the growth does not extend up the anal canal, surface application (combined with peripheral needling) may be an efficient and perhaps a superior substitute for seeds. If the glands in the inguinal region are involved, surgery followed by surface application is advisable. If there are no palpable glands, the lymphatic area may be treated by needles, seeds, or surface application. More experience is required before an opinion can be expressed as to the best method.

Radiation Prior to Excision.—There can be no doubt that in some instances an inoperable case can be rendered operable by the preliminary use of radium. In May, 1926, I used radium for a growth of the anterior half of the rectum which was adherent to the uterus and had perforated into the vagina. In February, 1927, the perforation had closed, the growth was much reduced in size and no longer fixed to the uterus, and the general condition of the patient had improved enormously. In March, 1927, I excised the rectum, and the patient is alive and well to-day.

In several instances I have employed radon seeds within the peritoneum at the time of colostomy prior to perineal excision for an operable growth. The seeds are inserted into the retrorectal space and along the line of the inferior mesenteric vessels. In two instances I have attacked an advanced inoperable growth with intrarectal radon seeds, and have found after some months' interval the general condition and the local condition so much improved that I have subsequently excised the rectum.

FIG. 406.—A specimen of carcinoma of the rectum excised following radiation with seeds. At A a seed is visible. Other seeds were found above the growth. Intussusception gave a false direction to the seed-introducer passed deep to the growth.

On several occasions when an attempt has been made to cure an operable case an incomplete disappearance of the growth has followed, and excision has been carried out at a later date. It might be expected that perirectal fibrosis and a diminished blood-supply resulting from radiation would increase the difficulty and impair the healing. Excision should not be delayed too long after radiation, so as to avoid the difficulties which may result from cicatricial contraction and adhesions. Up to the present the difficulties have not been noticeably increased, though healing after operation has been slower than usual. In the case referred to above, in which a rectovaginal fistula healed, the excision was exceptionally easy. There was complete atrophy of

the levatores ani, which greatly facilitated the operation, and hæmorrhage was almost negligible owing to atrophy of the blood-vessels. Whatever may be the ultimate verdict on the value of rectal radiation there can be no doubt that the power to convert an inoperable into an operable growth opens up a useful field which should be fully explored. If radium is employed within the abdomen, it is unlikely that any abdominal excision will be possible at a later date, owing to the plastic inflammation which usually follows.

Fig. 406 illustrates a rectum excised by the author after radiation with seeds had been carried out at the Radium Institute by a member of the staff. The growth, though situated above the peritoneal reflexion, could be drawn down to the anus. In this position seeds were inserted. In view of the extreme mobility of the growth the patient was transferred to St. Mark's for excision, which was carried out three weeks later. No obvious changes were apparent in the growth, and it was noted that, in consequence of the invagination, many of the seeds which were still present were found some distance from the growth.

FIG. 407.—Excision after radiation. The smooth floor of the ulcer is partly covered by regenerating epithelium. The area of growth beneath shows marked mucoid degeneration. (*Author's case.*)

Fig. 407 illustrates a rectum excised five weeks after intra-abdominal radiation with seeds (10 × 2·5 mc.). At the operation for the introduction of radium and colostomy the growth was found to be definitely operable, and was excised later by the perineal method. It is instructive to note the changes which have occurred. Most of the growth has been converted into islands of mucoid degeneration, and the surface of the ulcer is covered by new epithelium which has grown over a granulating area. *Fig.* 408 is a microscopic section of the tumour, and shows the new epithelium very clearly, and *Fig.* 409 shows the changes in the intima of the superior hæmorrhoidal artery, along which seeds were passed.

FIG. 408.—Microscopic section from *Fig.* 407. The section shows several collections of malignant cells in the submucosa and muscles, but the surface of the ulcer is covered with a thin layer of granulation tissue incorporating some healthy glands. These appearances are unknown in untreated cases, and indicate an attempt at healing and regeneration of the surface epithelium. A, Regenerated epithelium ; B, Areas of mucoid degeneration.
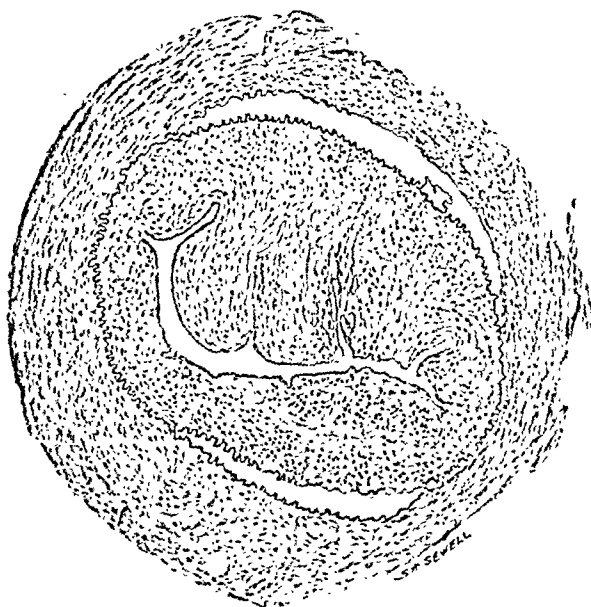
FIG. 409.—Proliferative endarteritis in the superior hæmorrhoidal artery from a case (*Fig.* 407) in which excision was carried out thirty-three days after radiation with seeds inserted into the mesorectum and growth.

Fig. 410 shows at A a smooth healed surface, without cicatricial contraction, which has followed radiation of an early growth. Unfortunately a second malignant tumour higher up was discovered three months later, for which excision was carried out.

Recurrence Following Excision.—In the past a local recurrence of carcinoma following excision of the rectum has seldom been amenable to successful surgery. In some instances response to deep X-ray therapy has been recorded, but these results were of a temporary nature. Three cases have been treated with needles alone or combined with external radiation on Columbia paste. No case has been under observation long enough to enable one to express an opinion as to cure, but results so far have been much more encouraging than could have been anticipated. One of these cases may be cited :—

Case 3.—A patient came under observation two years after a perineal excision in India. Exploration of a discharging sinus revealed an extensive and diffuse infiltration of the scar tissue in the perineum. A portion of this tissue was removed and proved to be adenocarcinoma. The infiltrated area was given a heavy dose with needles and this was followed by intensive surface radiation with Columbia paste (total dose 14,000 mgrm.-hrs.). In spite of considerable delay in healing, and severe peripheral neuritis, which was undoubtedly due to an overdose, the patient returned to India a year later apparently cured of his recurrence.

Recurrence Following Radiation.—In all branches of surgical radiation it happens unfortunately that apparent cures relapse or that a tumour shrinks to small proportions and then resumes active growth. Such results no doubt will become less frequent with increased experience. So far as this present series of cases is concerned, a recurrence seems more likely to follow after the use of radium seeds than needles, and it appears probable that the diminishing intensity of radon, as opposed to the constant intensity of radium, is the causal factor. It may be possible to overcome the factor of diminishing intensity by additional radon at short intervals, which can be done in certain situations,
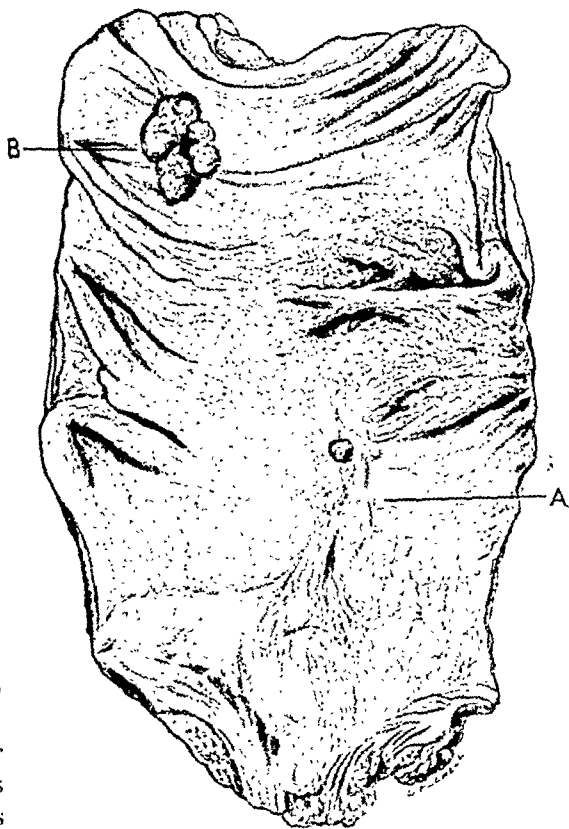
Fig. 410.—Results of radiation. Rectum excised for carcinoma shown at B. At A there is a puckered scar resulting from radiation of a carcinoma nearly three months before the second growth was discovered. No carcinoma could be discovered on section of tissues behind the scar. The small nodule at the upper end of the scar was quite soft. The growth treated was about 1½ in. in diameter. (*Mr. Gabriel's case.*)

by reinforcement—that is, by supplying

especially when general anæsthesia is not required. Another method which the author has tried is to combine intrarectal seeds with perirectal needles, a method which minimizes the loss of intensity, though it does not give a uniform intensity. In several instances, when retrogression of the tumour has appeared to be complete (or nearly so) and recrudescence has followed, radiation has been repeated (in a few cases more than once), but in no instance has the result been entirely satisfactory. These remarks do not apply to those cases which have been treated by intra-abdominal radiation followed by intrarectal radon seeds, some of which are still under favourable observation. Without doubt primary radiation increases radio-resistance to secondary radiation, and further, in the author's experience, secondary radiation often produces considerable pain of a type which suggests a neuritis and appears to involve the sacral plexus. In the light of present experience, excision when possible must be recommended when radium fails at the first count.

With inoperable cases it is worth while to persevere, provided that marked improvement for a period follows initial treatment. It is in this type of case that secondary treatment with the intrarectal 50-mgrm. tube may be found useful, if not used too soon after the primary treatment. Some cases of this type have been treated by deep X-ray therapy after radiation and no marked improvement has followed. It would, however, be unwise to report unfavourably on the value of deep X rays after radium, as the method has not yet been given a fair trial. So far as experience goes at present, deep X-ray therapy seems to be of more use before than after radium.

Relapses following apparent success are so frequent that it is evident some improvement in technique is required, and it is essential to explore to the full the combination of interstitial radium therapy with deep X-ray therapy, and with telecurietherapy when it becomes possible.

RESULTS.

This paper is based on the experience gained with the treatment of 93 cases of cancer of the rectum with radium during the past five years up to the end of 1929. Many of the cases are so recent that any assessment of results on a statistical basis at the present time would prove fallacious. In certain instances it has been demonstrated : (1) That an early growth on the anterior wall of the rectum can be destroyed by needling through the vagina, and that the rectum at the site of growth can be restored to its normal appearance and calibre ; (2) That a similar result can be secured by introduction of seeds directly into a small growth without colostomy ; (3) That a large fixed inoperable growth can be destroyed by perineal radiation, with a resultant fibrous stricture, and remain well (four years); (4) That an inoperable high growth can be apparently cured by abdominal radiation and remain well (two years), and further that a colostomy is not always essential ; (5) That a fixed inoperable growth can be rendered operable ; (6) That a perineal recurrence can be made to disappear ; (7) That the worst and most advanced cases can be made more comfortable by relief of symptoms.

It is true that the successful cases form a small percentage of the total, but the fact that radium can accomplish these results is a great encouragement to persevere.

With perhaps the exception of the œsophagus, no branch of radium therapy which is practised to-day presents greater difficulty of access. Many other difficulties arise, especially with regard to uniform distribution, lymphatic spread, sepsis, bladder complications, and adequate observation of the progress of the case, and it is not surprising that some workers with much experience of radium have abandoned the pursuit and are content to write off carcinoma of the rectum as radio-resistant.

It is quite certain, if brilliant successes can be secured in a small percentage of cases, that increased experience must reduce the failures and add to the successes, though difficulties will always remain which are sometimes insurmountable.

To secure a low mortality for excision of the rectum—that is, lower than the average—calls for either a careful selection of cases, or experience and skill above the average. Time will show whether a combination of these three factors will vastly improve results in radium therapy in all its branches, or will reveal that radium is too capricious a master and too little a servant to be reckoned with as a serious fighting factor in the campaign against cancer.

Until we are in a position to measure the action of radium with some accuracy, to be able to say with confidence that a given dose of radium administered in a given way for a given time will produce a certain result, we are, I think, in duty bound to advise surgery, mutilating though it is, in preference to radium for the operable case. Where, however, as sometimes happens, the growth is operable, but the patient is considered unsuitable for radical surgery on other grounds, then I believe radium holds out great though uncertain, prospects of cure, and should always be employed when available.

When passing in review the results of my work with radium during the past five years I do not doubt that, with increasing experience, we shall be able to cure, year by year, a higher though small percentage of inoperable cases which can be cured in no other way, and I am satisfied that with judicious selection of cases we can assist those who have passed beyond the prospect of cure, by giving them hope, by alleviating their symptoms, and by prolonging their lives, even though in some instances our best efforts result in complete failure.

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CONGENITAL NON-ROTATION OF THE INTESTINE.

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THE present case was that of a girl, age 8 years, who since birth had suffered from attacks of what had been called gastritis. These attacks had occurred at approximately six months' intervals. The symptoms during the attacks had been : (1) Epigastric pain on the right side of the mid-line; this was intermittent, and did not seem severe. (2) Vomiting, which was not obstructive; the vomit consisted of ingested food, and was not bile-stained; the vomiting was not continuous, but occasional. (3) Malaise. The attacks lasted three to seven days, subsiding gradually. For the improvement credit was given to powders prescribed by the patient's doctor. In the intervals the bowels were quite regular, there was no indigestion, and the appetite was good. In spite of a good appetite, however, the child did not thrive.

The first of the attacks occurred three days after birth, and lasted till the seventh day. The child vomited all her feeds. There was no bile in the vomit. The final attack, which terminated fatally, commenced a week before the patient's death in the usual way, but gradually became more severe during the first four days. Constipation was absolute, no fæces or flatus being passed during this time. On the fourth day the patient's pulse was rapid and her face flushed. She complained of severe pain in the epigastrium and right hypochondrium. On examination there was intermittent rigidity in the right hypochondrium, but no definite tenderness, i.e., pain was not increased by palpation. There were no localizing signs in the abdomen. An enema was administered with a poor result. Vomiting continued, and was greater in quantity than the fluid taken by the mouth. On the fifth day the vomit became bile-stained and copious. On the sixth day the pulse was very rapid and thready, and the vomit became thick and dark coloured; it was the vomit of high intestinal obstruction. The patient was too ill for surgical interference. She died on the seventh day.

AUTOPSY FINDINGS.—The liver was normal, the gall-bladder slightly distended. The first part of the duodenum was also distended, the second part descended obliquely, with a slight inclination from right to left, crossing the mid-part of the transverse colon, while the remainder of the duodenum was twisted and constricted at the volvulus of the mesentery. The cæcum was in the right iliac fossa, but its posterior surface with the appendical junction was anterior. The left half of the transverse colon was normal in colour, while the right half, the ascending colon, the cæcum, the appendix, and the whole of the small gut were intensely congested. There was a considerable constriction at the mid-point of the transverse colon, where the duodenum crossed it. The cæcum and ascending colon were freely movable.

By rotating the gut involved in the twist in an anti-clockwise direction, through an angle of 180°, the volvulus was undone. The cæcum was then in the left iliac fossa, with its appendix junction posteriorly. The ascending colon passed up from this on the left side of the vertebral column, and with the right half of the transverse colon formed a loop whose concavity was on the left side. The terminal part of the ileum passed from right to left to join the cæcum. The lower part of the duodenum and right half of the transverse colon lay close together. The superior mesenteric artery passed down on the left side of the duodenum and on the right side of the constriction in the transverse colon. At this point the transverse colon passed through a tunnel of the mesentery.

The omentum on the left side was attached, as usual, to the stomach and transverse colon, but further to the right it was attached to the mesentery
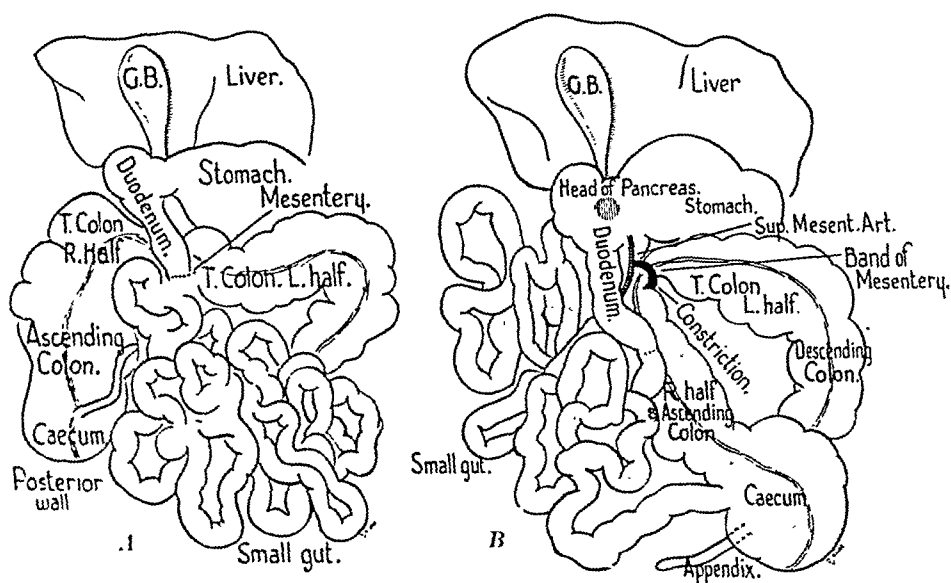
Fig. 411.—Congenital non-rotation of the intestine. A, With volvulus ; B, Volvulus untwisted. The shaded area shows the congested portion of the bowel.

at its fixed point, to the right side of the duodenum, and to the front of the right kidney. The cæcum with the appendix, the ascending colon, the right half of the transverse colon, and the whole of the small intestine were suspended by a common mesentery which had a comparatively short attachment to the posterior abdominal wall high up. This attachment was transverse with a slight inclination downwards and to the right; on the right side the attachment was to the anterior surface of the right kidney. This segment of the gut corresponds to the congenital mid-gut. The gut was narrowed at two places, in the lower part of the duodenum, and in the middle of the transverse colon. Through a volvulus of the 'mid-gut', its mesentery had been twisted through an angle of 180°, causing venous engorgement and complete duodenal obstruction. (Fig. 411.)

Other Reported Cases of Anomalies of Intestinal Rotation.—A similar case is reported by Norman M. Dott[1] in a baby in whom the symptoms made

their appearance on the fifth day after birth. In that case there was acute obstruction in the lower part of the duodenum. Dott also quotes two cases from the French literature. In the case under discussion obstruction became complete only toward the end of the terminal attack.

Dott discusses the whole question of anomalies of intestinal rotation in their embryological and surgical aspects, and states that in infants with such anomalies extensive volvulus with acute duodenal obstruction may be met with. The child is normal when born, remains so for some days, meconium is passed, and if the onset of volvulus has allowed time, food residues appear in the motions on the third or fourth day. Vomiting begins early, and occurs in relation to food. The vomit is soon deeply stained with bile. In later stages there is gastric dilatation and erosion. Gastric peristalsis may be observed. The upper half of the abdomen becomes distended (stomach and duodenum); the lower half is recessed from collapse of the intestine. The degree of constipation varies with the degree of obstruction.

In the case at present reported the child was 8 years old; she had had many attacks of 'gastritis', which in all probability were due to partial volvulus of the mesentery with its very short attachment. Not until the final attack was the twist sufficiently severe (180°) to cause mesenteric engorgement to an extreme degree, and duodenal obstruction.

G. E. Waugh[2] records five cases of congenital malformation of the mesentery which had come under his own notice, none of which, however, was similar to the case under discussion. Four of these cases he diagnosed before operation. He says that the pain the patients suffered was characterized by its 'unusualness', that the vomiting was erratic and rare except in one case, and that in four cases out of five there was an asymmetrical fullness of the abdomen, the right iliac fossa being empty. The symptom complexes, Waugh says, cannot be explained by reference to any of the well-known surgical diseases. The ages of the patients were 6½, 12, 10, 21, and 7½. Radiological examination did not afford help except in the last case of the five, where, after the bismuth meal had entered the small intestine, as observed by screening, a barium enema was also given. Waugh advises this procedure.

It is noticeable that the patient under discussion had her first attack when only a few days old, as in the case reported by Dott, but lived for eight years with recurring attacks, to succumb finally from a twist of her mesentery that brought about acute congestion of her mesenteric veins and obstruction of her duodenum.

[NOTE.—It has been suggested that the case above reported is one of 'reversed rotation' rather than of 'non-rotation'. In the writer's opinion, it is a case of non-rotation that by volvulus has become one of reversed rotation. The anatomical findings fit in with this conception.]

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FAT NECROSIS OF THE BREAST.

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INTRODUCTION.

THE commendable modern practice of radically excising any new formation bearing a reasonable clinical likeness to malignant disease in a patient of the cancer age has brought into some prominence, and provided examples of, an innocent lesion of the breast presenting itself most often in women between the fourth and fifth decades, frequently as a stony-hard tumour firmly fixed to the skin, often resembling an early cancer so closely that a wide resection of the breast has been performed. In a few cases a similar lesion has appeared in relation to the scar following breast amputation for cancer, and the likeness to recurrent growth has been equally deceptive.

The lesion in the majority of cases is a relatively small mass of traumatized subcutaneous fat undergoing quiet and usually painless sterile autolysis or heterolysis whose bulk is added to by the accumulation, in it of phagocytes engaged in the absorption of fatty acid and fibroblasts initiating repair. Eventually the lesion cicatrizes and any unabsorbed fat and saponification products become enclosed in mature fibrous tissue. A thick-walled cyst containing dark fluid results, and calcification is frequent in the late stages.

The central feature of the process is slow aseptic saponification of neutral fat by blood and tissue lipase analogous to pancreatic fat necrosis, but much milder in degree and independent of any direct action of pancreatic lipase.

The lesion arouses suspicion chiefly by reason of its situation in the fat overlying the breast, and copies the physical signs of cancer most closely in the early and middle stages of its evolution, when it is usually stony hard. At no stage does its naked-eye appearance on incision or its microscopic characters bear a close resemblance to cancer, but its histology may conceivably suggest tuberculosis.

As a naturally occurring pathological process, extraperitoneal fat necrosis was described by Shattock[1] in 1896 in a lipoma of the thigh. In the same number of the *Transactions of the Pathological Society of London* is an article by Targett[2] describing a similar lesion in a lipoma of the breast. They called the lesion 'saponifying necrosis'. Lanz,[3] of Berne, in 1898 described an identical lesion in subcutaneous fat as 'traumatic fatty necrosis', indicating its frequent association with injury. Heyde[4] in 1911 described it in the fat of the thigh, and quoted two other cases. Küttner[5] in the same year described it in abdominal and extra-abdominal fat, but it was left to Lee and Adair[6]

in three publications between 1920 and 1924 to draw attention to the fact that when fat necrosis affects the cellulo-adipose tissue over or in the breast, the lesion may be extremely difficult to distinguish from early cancer. Amongst their conclusions are : (1) " Traumatic fat necrosis of the breast is a definite clinical entity." (2) " It must always be included with the benign lesions of the breast." (3) " Clinically it more closely resembles carcinoma of the breast than any other tumour." (4) " A distinct history of trauma to the breast and a well circumscribed mass showing rapid increase in size, unassociated with pain and without axillary nodes that are firm, suggest the possibility of fat necrosis." (5) " The diagnosis of traumatic fat necrosis of the breast by gross examination is possible." The gross features of the lesion should therefore be clearly understood by every surgeon.

Further observations have amply confirmed most of these findings. It appears, however, that the importance of the traumatic factor was overstated by Lee and Adair, and not enough stress laid on the fact that in quite a fair percentage of cases the clinical resemblance to cancer is superficial and unlikely to lead to excision. Farr[7] in 1923 described a similar lesion in the subcutaneous tissue of young infants probably due to birth injury, and published instructive experiments on the mechanism of sterile in vitro lipolysis. He produced the lesion in young pigs by pinching the skin and subcutaneous tissue with forceps. From 1923 up to the present time further information has been supplied by Gottesman and Zemansky[8] from America, by Roffo[9] from the Argentine, by Stultz, Diss, and Fontaine,[10] and by Lecène and Moulonguet,[11] from France, and by Keynes,[12] Hadfield,[13] and Moir[14] from Great Britain.

It would be misleading in the introduction to this paper if some attempt were not made to place the subject of extra-pancreatic fat necrosis in its proper perspective from a purely pathological point of view. That traumatized or ischæmic fat in any situation in the body can and often does undergo quiet sterile autolysis or heterolysis, resulting in saponification, and the phago-cytosis of chemical products of saponification by histiocytes and giant cells, is a well-established general principle in the pathology of repair.

Shattock's account written in 1896 of the changes found in his case of 'saponifying necrosis in a lipoma of the thigh' is an exact description of the two phases in the evolution of 'fat necrosis' as seen in the breast. He saw " an opaque white necrotic area in the centre of the lesion and near by another focus in which softening had taken place with the production of a pseudo-cyst ". He remarks that " the oil in the cells undergoes saponification, combinations taking place between the fatty acids and the lime and soda salts of the plasma which infiltrates the dying tissue ", and that " a few cells hold the delicate radiating crystals of solidified fat, while others are filled with a crystalline coarsely fissured substance ".

M. J. Stewart has fully described this and similar tissue reactions to fat, lipoid, and saponification products in several papers in which the uniformity of cell response to these substances in many situations is clearly demonstrated. For example, fat necrosis often affects adherent extraperitoneal fat in the sacs of herniæ, and the identical nature of the lesion to that occurring in the breast can be easily demonstrated.

Fat necrosis of the breast is therefore by no means unique as a pathological process; its importance lies in its liability, purely due to situation, to mimic the clinical signs of mammary cancer. This being so, it is imperative that its naked-eye appearance and microscopic characters be well established.

CASE REPORTS.

Case 1.—Mrs. M., age 45, with eight children alive and well, has had a lump in the right breast for the last two and a half months. She has had pain off and on in this breast for fifteen months, dating from a week or so after lactation and persisting throughout the whole period of eight months. At first, on putting the child to the breast, the gland became full, tense, and painful, but no lump was noticed. The tenseness subsided in about ten days, but the pain continued off and on during the rest of lactation. She weaned the child after eight months, and for the next four months, during which there was amenorrhœa, there was no pain, swelling, or lump. When menstruation recommenced and at the end of the first period the pain was again noticed, and continued monthly, but until two and a half months ago no lump was noticed. There has been no discharge from the nipple except on one occasion, when there was slight serous discharge lasting one day. Since the lump has appeared it seems to vary in size, is sometimes large and soft, at other times smooth and 'very hard'.

CLINICAL EXAMINATION.—The patient is well-covered, but not obese. The breasts themselves are not unduly fat. In the upper lateral quadrant of the right breast there is a hard, somewhat craggy mass the size of a bantam's egg, not tender on touch or manipulation. The skin over the tumour is adherent to it and shows the *peau d'orange* appearance. The lump is fixed to underlying tissues, but not very firmly. Several rather hard glands were felt in the right axilla, none in the left. There was no nipple retraction. Early cancer of the breast was diagnosed and a radical excision performed.

Comments on Clinical History.— The lump was noticed only two and a half months before operation, and the pain during lactation was not localized. There was no history of precise trauma, the patient was not very obese, nor were the breasts pendulous. The skin was not ecchymotic over the lesion. There is therefore no clear connection with trauma or with lactation. For these

FIG. 412.—Case 1. Chalky-white mass with central area of liquefaction. Many small chalky particles lying in peripheral fibrous tissue. (× 3.)

reasons, and in view of the fact that the breasts were not very heavily laden with fat, a pre-operative diagnosis of anything but carcinoma in this case would have been unjustified.

PATHOLOGICAL EXAMINATION.—The hard mass felt in the upper lateral quadrant was lying 1 to 5 cm. below the skin, was roughly ovoid with rather ill-defined boundaries, and measured 5 cm. by 4 cm. in its principal diameters. On section it was found to be lying outside the mammary gland proper, but firmly attached to its axillary prolongation. The central part was cystic, and contained yellowish-brown fluid, greasy debris, and small chalky-white particles. Around the cyst was

FIG. 413.—*Case* 1. Low magnification of section of lesion. Central cavity surrounded by compact wall of autolysing fat and phagocytes. Normal fat below and to the left. Breast tissue above and to the right.

FIG. 414.—*Case* 1. Section of autolysing fat surrounding central cavity. Many large fat phagocytes with small nuclei. Rich infiltration by lymphocytes.
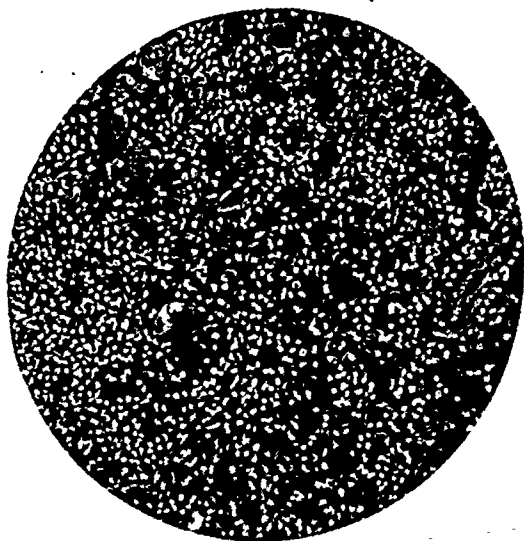
a thick prominent zone of opaque chalky-white tissue surrounded by an irregularly-contracting pinkish zone containing many isolated irregular white chalky masses resembling that surrounding the central cyst (*Fig. 412*). The mammary gland itself appeared normal. No glands were found in the axillary fat.

FIG. 415.—*Case 1.* Field showing cigar-shaped clefts previously occupied by saponification products, lined by foreign-body giant cells.
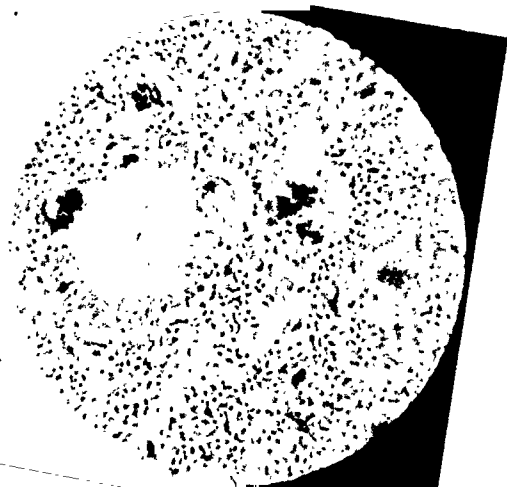
FIG. 416.—*Case 1.* Mass of fatty acid crystals surrounded by multinucleated giant cells.

Histologically, the 'cyst' was found to be an unlined cavity lying in the centre of a cellular mass irregularly invaded by peripheral fibrosis (*Fig. 413*). The central part of the mass was almost avascular and crowded with large mononuclear phagocytes distended with fat in fine emulsion, multinucleate giant cells containing coarse isotropic crystals having the physical properties and giving the staining reaction of fatty acid, and small more delicate crystalline masses staining deep violet with Nile-blue sulphate, but becoming partly homogenized at 45° C. These masses were in all cases completely enclosed in a wall of large multinucleate giant cells (*Figs. 414–417*). Towards the periphery the lesion was fairly densely infiltrated by plasma cells and lymphocytes, with a moderate number of polynuclear leucocytes at one part, and many fibroblasts towards the edge, where there were many young capillary vessels.

Case 2.—The patient, age 41, had noticed a lump in the left breast for one month. It was slightly tender but not painful. There was no history of local trauma to the breast or general trauma involving that side of the chest.

FIG. 417.—*Case 1.*—Similar giant cell to that seen in *Fig. 416.*

FIG. 418.—*Case* 2. Early fat necrosis. Low magnification of whole lesion. Central area of liquefaction with breast lobules peripheral to it. Microphotographs taken from the tissue lining the lower half of the liquefaction cyst.

CLINICAL EXAMINATION.—The patient is thin but healthy. The affected breast is small and nodular, and the tumour, which lies in the upper lateral quadrant, is cystic, the size of a small hen's egg, not attached to the skin or muscle, and there is no retraction of the nipple. One soft gland was felt in the axilla. There was no ecchymosis of the skin. Local excision of the tumour was performed.

Comments on Clinical History. —Again there is no history of localized trauma. Carcinoma was not considered, as the lesion was well away from the gland and cystic.

PATHOLOGICAL EXAMINATION.— A small cystic mass was found lying 3 cm. below the skin well away from the body of the mammary gland. It was ill-defined, and measured 3 cm. by 1 cm., the long axis being parallel to the skin. The cyst was an unlined central cavity containing oily fluid and surrounded by a thin, opaque, whitish-yellow zone, fading into a pinkish, poorly defined peripheral area (*Fig.* 418).

Histologically the tissue at the edge of the central cavity was composed of closely packed mononuclear phagocytes crowded with fat droplets (*Fig.* 419). Towards the edge these were accompanied by many young fibroblasts, which were numerous at the periphery,

FIG. 419.—*Case* 2. Field showing phagocytic cells filled with finely emulsified neutral fat.
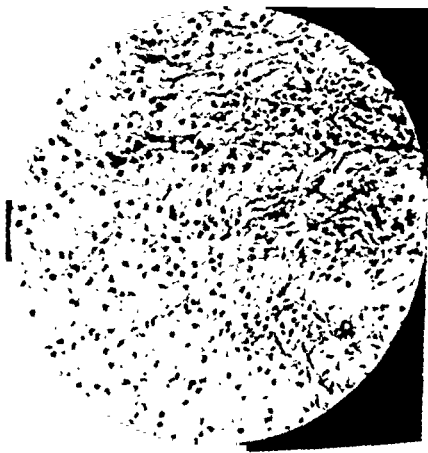
FIG. 420.—*Case* 2. A similar field showing invasion of phagocytic zone by fibroblasts.

where they resembled a tissue culture of these cells (*Fig.* 420). Fatty acid crystals
and multinucleate giant
cells were absent. The
contents of the central
cavity were acellular and
stained rose to lilac with
Nile blue. The cellular
zone at the edge stained
mauve to violet.

Case 3.—The patient,
age 57, had a complete
excision of the breast
performed for a small
carcinoma growing in the
upper lateral quadrant.
The diagnosis was con-
firmed microscopically.
No glands were found in
the axillary fat. The
wound healed by first in-
tention except for a small
length in its lower and
inner portion; this part
healed by granulation
without incident in about
three weeks.

Fig. 421.—*Case* 3. Fat necrosis simulating recurrent cancer. Low magnification of about one-third of the whole lesion. Multi-locular cyst, walls of mature fibrous tissue lined on inside by phagocytic cells, many multinucleated and containing oily débris.

She noticed pain and
indefinite swelling in the
upper part of the wound
about 1½ cm. from the anterior fold of the axilla nine weeks after the operation,
but did not report it until twelve
weeks after operation. A hard mass
was then found about the size of a
cherry, its centre 1¾ in. below the
clavicle, its lower limit reaching the
healed operation wound. It was
firmly fixed to the skin and to the
deep tissues. Indefinite fluctuation
was felt. There was no other lump
in the skin; the axilla was empty.
Recurrent growth was confidently
diagnosed and a wide excision was
carried out.

PATHOLOGICAL EXAMINATION.—
The lesion was well defined, measured
5 cm. by 4 cm. in its principal axes,
and consisted of a central cavity with
ragged edges and brownish oily con-
tents, completely enclosed in a thick
fibrous wall. The cavity was divided
into three unequally sized compart-
ments by a broad branched band of
fibrous tissue (*Fig.* 421).

Fig. 422.—*Case* 3. Mass of multinucleated giant cells composing wall of one of the cystic spaces.

Microscopically, the contents of
the cavity were acellular and fatty,
the wall lined on its inner surface by
a cellular layer varying considerably in thickness and composed of large numbers
of multinucleate giant cells, the majority containing fat in fine emulsion (*Fig.* 422),

a few containing a very fine feathery crystalline deposit which did not stain satisfactorily with Nile blue and was not doubly refractile, but melted at 45° C. These crystals were taken to be neutral fat. The cellular zone was irregularly invaded by fibroblasts. The capsule was composed of mature fibrous tissue.

DISCUSSION.

I have been able to find 42 fully recorded cases of necrosis of the fat over or in the breast with the production of a tumour: these with the 3 cases recorded in this paper bring the total number to 45. The large majority occurred in the fourth and fifth decades in married women. The average age was 50; only 12 per cent of the cases were under 40; one is reported at the age of 19. There appears to be no constant association with lactation: in several cases there was no history of lactation; in the majority it was a remote event. In at least 40 per cent there was a clear history of rather severe trauma to the breast; in many of these there was considerable ecchymosis at the time, and in all of them, apparently, the tumour arose where the injury was inflicted. In one group of cases reported the trauma was inflicted during subcutaneous infusion by saline. In Lee and Adair's series of 20 cases a history of severe trauma was present in 70 per cent. They lay stress on the fact that the site of the tumour and the location of the injury are identical. In cases reported by other observers this history of precise trauma was less frequently obtained.

In cases where no traumatic history could be elicited, the site of the tumour appears to have been much more frequently in the upper and outer quadrant of the breast than elsewhere. The history of duration of the tumour varies from two years to ten days, but in the large majority of cases the lump had been noticed for two and a half months before seeking advice, and a history of progressive increase in size of the mass is common. Pain was complained of in the minority of cases, and tenderness in some, but neither pain nor tenderness is a common feature. There is no history of discharge from the nipple. Lee and Adair laid great stress in their papers on general obesity, and especially a fatty, pendulous, or projecting breast, as being present in the majority of cases. Judging by accounts of cases reported since theirs, this conclusion appears to have been justified, but, as Gottesman and Zemansky point out, the condition may occur in thin women.

The extent to which fat necrosis may mimic the clinical signs of cancer may be judged from the fact that of 45 collected cases, 12 (26 per cent) have had a radical excision of the breast, pectoral muscles, and axillary contents performed. The history of progressive increase in size may suggest cancer, and the clinical characters of the growth fairly frequently confirm it. In 66 per cent of the cases the mass is described as 'stony hard', 'as hard as a scirrhus', or as 'very hard', etc. In the remainder it is usually described as 'firm'; in a few cases as being 'firm with an area of fluctuation'; in one case as having ulcerated through the skin. The size of the tumour, as felt through the skin, varies from a diameter of 7 cm. to 1½ cm. or is described as being the size of a bantam's egg, a lime, a tangerine, a large bean, a large pea, etc.

In at least 52 per cent the mass is noted as being adherent to the skin.

and in these cases the skin is fairly frequently described as showing the *peau d'orange* appearance. In only 10 per cent of cases at the most was there retraction of the nipple, and in about the same proportion the tumour was fixed to the deep tissues. When enlarged axillary glands were reported as being present, they were usually described as 'soft'. The tumour was generally described as being well-defined on palpation, but in at least 20 per cent of cases as being diffuse. It seems that if seen at a very early or a very late stage, it tends to appear diffuse, but in the intermediate stage of its evolution —that is, about two to four months after its appearance—it is usually well-defined, but hardly so well-defined as carcinoma. The naked-eye appearance of the lesion on section varies considerably, but at no stage is it likely that an experienced observer could mistake it for mammary cancer. The earliest lesions up to a fortnight in duration are often seen to occupy exactly one or two fat lobules, the outlines of which can easily be traced. These lobules in normal breast fat are usually ovoid and measure from $\frac{1}{2}$ to 2 cm. and from $\frac{1}{4}$ to 1 cm. in their principal axes. and early lesions vary in size from $\frac{1}{2}$ cm. by $\frac{1}{4}$ cm. to 4 cm. by 2 cm. At this stage the lesion is strikingly opaque. white, and dull, especially if lying surrounded by yellow fat lobules; the periphery of the lesion is pinkish. The colour may be whitish-yellow or xanthoma-like, but is much paler than the fat.

In early lesions the lack of cicatrization makes it easy to recognize that it is lobular in size, shape, and distribution; but even in these there may be central liquefaction, with the production of a pool of yellowish oily fluid. Very soon the lesion grows more chalky in appearance, and as it becomes invaded by peripheral fibrous tissue the unbroken central chalky area is split up, the edge becomes irregular, the lobular configuration is lost, and the appearance is that of many minute rounded and irregular fragments rather like candle grease in appearance, lying in pinkish connective tissue. At this stage there is usually some central liquefaction, or not infrequently a relatively large pseudo-cyst develops. The fluid in the cavity may be yellow and oily. It is often brownish in cases with a history of considerable and precise trauma. From this stage the appearance is altered by the slow development of a fibrous-tissue capsule, by cicatrization, and more extensive cyst formation, but the small fragments of white or whitish-yellow necrotic fat resembling candle fat remain in the lesion for several months at least.

At all stages the lesion feels firm to the touch, but it has never the hardness of scirrhous cancer when cut across, is never quite so well defined, and the areas of white or yellow opacity in it are larger, more irregular in shape, and do not radiate from the centre of the lesion in the manner of the fatty streaks seen so frequently in mammary cancers. In addition there is not the same tendency for the tumour to appear concave on section or for the rich development of pink translucent bands of fibrous tissue which are seen in scirrhous carcinoma. In some cases the lesion is irregularly and lightly pigmented by hæmosiderin deposit. In old cases there is irregular calcification, and the lesion is usually cystic.

Neutral fat can be demonstrated in the lesion in most cases of fat necrosis of the breast, and in the early ones in fairly large amounts mixed with fatty acid. The lipolysis is slow and incomplete, and, considering the amount of

tissue destruction, the peripheral inflammation is mild.   There can be little doubt that there is no infective factor.   In pancreatic fat necrosis all neutral fat is rapidly transformed into soap and fatty acid, and in all probability the rapidity of tissue destruction is aided by trypsin proteolysis.   Compared with the lesion in the fat of the breast, fat necrosis of the pancreas is, as expressed by Lecène and Moulonguet, " une phénomène massif et très brutal,—une saponification complète,—une véritable cadaverisation."

The amount of free lipoid in the lesion described in the paper, as judged by examination through crossed Nicols, was negligible, and the crystalline deposits surrounded by foreign-body giant cells were usually demonstrated as being fatty acid.

When the lesion occurs in the fat immediately under the skin over the breast it is very unlikely to suggest cancer, and Lee and Adair classify the condition into two groups, those occurring in the fat of the gland itself and those occurring in the fat overlying it.   Gottesman and Zemansky describe it as being formed in the fat overlying the breast, as a single tumour in an otherwise normal breast, as multiple punctate areas in a breast the seat of some other pathological process, or in a lipoma of the breast.   Their third group is difficult to accept as being precisely the same lesion as the others, for many such lesions originate from duct obstruction and the fat is derived from the secretion of the gland.   The tissue reaction is undoubtedly similar.

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NOTES ON MALIGNANT TUMOURS.*

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A STUDY of the clinical histories and pathological changes occurring in 700 patients suffering from malignant tumours who were admitted as in-patients into St. Giles's Hospital during a period of just over five years, form the data for this article. All but thirty of these patients were found to have malignant tumours originating in epithelial structures; and as a result of these investigations, aided by a study of over 160 post-mortem examinations, certain facts bearing on the problem of carcinoma were ascertained. Three factors in particular were found to play an important part in the diagnosis, pathology, and treatment of malignant tumours:—

1. The first factor consisted of the *mechanical* changes associated with the proliferation of the tumour cells; and the resulting strictures of hollow organs or pressure effects on neighbouring structures led to complex changes in the body, but were frequently amenable to simple surgical procedures.

2. The second factor consisted of the *infective* changes which occurred directly or indirectly as a result of the activity of the tumour cells. This factor was considered to be of the utmost importance in malignant disease, and was responsible for a large proportion of the deaths which occurred in this series of cases.

3. The third factor was the property of *dissemination* which is a characteristic of malignant cells, and which may result in widespread metastases and give rise to puzzling clinical pictures as well as lead to disappointment in the results of treatment.

The 700 patients have been classed into eight sections: (1) 71 who had the primary tumour situated above the level of the larynx; (2) 22 with carcinoma of the larynx; (3) 8 having primary growths of the lung, and 8 with primary growths originating in mediastinal structures or in the pleuræ; (4) 317 suffering from carcinoma of the alimentary canal; (5) 82 who had carcinoma of the breast; (6) 56 with tumours originating in the male genito-urinary tract; (7) 99 having tumours of the female genito-urinary tract; (8) 23 with abdominal carcinoma of uncertain primary origin, and 14 cases of miscellaneous tumours.

An examination of the cases included in these different sections showed the importance of the three factors mentioned above relative to the anatomical site of the primary growth. Detailed reference to these cases would be too lengthy for this contribution, but before presenting the conclusions which

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* These 'Notes' are part of an abstract from a thesis submitted for the degree of Master of Surgery of the University of London in 1928.

are based on an examination of the evidence provided by them, it is advisable briefly to outline the prominent characteristics noted in the different sections.

Section 1.—The cases included in the section comprising patients who had the primary *tumour above the level of the larynx* demonstrated the importance of the infective and mechanical factors in the symptomatology and progress of malignant disease. Dissemination of the tumour cell had not occurred beyond the cervical lymphatic system, and there was strong evidence pointing to a causal relationship between infective changes in the glands and invasion of the periglandular tissues. Relatively clean ulcers were accompanied by discrete glandular masses, foul ulcers were accompanied by fungating masses in the neck. The constitutional changes present in many of these patients were considered to be due entirely to a combination of the mechanical changes which interefered with deglutition, etc., and infection of the growth. Sepsis in the primary growth was responsible for serious lung lesions such as inhalation pneumonia, as well as for the usual complications which may arise from infected wounds.

Section 2.—The importance of the infective factor was very marked in *carcinoma of the larynx*; and the importance of sepsis relative to anatomical situation was clearly demonstrated—a small ulcer situated at the inlet of the lower respiratory tract being far more dangerous than a large fungating area situated, for example, on the chest wall. The mechanical changes resulting from the growth also aggravated the danger of pulmonary complications. Dissemination involved the local lymph drainage area, and infection of the primary growth appeared to have an influence on the extent of invasion of the surrounding tissues.

Section 3.—The serious changes which may result from the pressure effects of metastases were demonstrated by the cases of *bronchial carcinoma*. In these cases the tracheo-bronchial lymph-glands had been invaded, and their expansion due to the metastases produced lesions in the lung as a result of pressure on other structures in the hilum. Interference with the blood-flow in the pulmonary veins appeared to be of particular importance in the pathology, and gave rise to changes in the lung parenchyma well away from the primary growth. Congestive areas, pulmonary œdema, pleural exudate and adhesions, and even necrotic areas of lung tissue were apparently due to this mechanical factor; and these lung changes were the immediate cause of death. Examination of all the cases on which the present article is based suggests that these glands tend to be invaded in the later stages of all varieties of carcinoma, particularly in those cases in which the mechanical and infective factors are not dominant. Thus, for example, a clinical picture at first thought to be due to an unresolved pneumonia was found to be secondary to a carcinoma of the prostate, and in several other patients the lung changes were the first indication of a serious lesion in other parts of the body.

Section 4.—The cases of *carcinoma of the œsophagus* demonstrated the seriousness of mechanical obstruction. Many of those having the growth at the level of the fifth dorsal vertebra had metastases in the tracheo-bronchial glands, which led to the lung changes characteristic of the pressure effects due to enlargement of these glands.

The advanced cases of *carcinoma of the stomach* frequently had a wider dissemination of metastases than is usually recognized. Intrathoracic metastases were common, and probably resulted from the lymph paths opened up by invasion of the liver capsule.

The serious effects of mechanical obstruction of the intestine were seen in the cases of *carcinoma of the colon*; fatal infective complications were met with in patients who had a primary growth that might have ended in excellent results had earlier hospital assistance been sought. Distant metastases appeared to occur far less rapidly than in other types of tumours.

Carcinoma of the rectum showed the indiscriminate destructive action of the primary growth. Infiltration of the bladder led to urinary fistula and to ascending urinary tract infection. The perineum and abdominal wall tended to be invaded by a slow-spreading destructive ulcer which when infected led to fungating masses in the lymph-drainage areas. Dissemination in cases of long duration was widespread, and appeared to be confined within the boundaries of the lymphatic system except in such organs as the liver.

Section 5.—The dissemination of malignant cells was well demonstrated in the patients suffering from *carcinoma of the breast*, several in whom the infective factor was negligible having extremely widespread metastases. Pathological fracture of the femur occurred in one patient, who had acute carcinoma, within a few weeks of the onset, and the rapid occurrence of backache and evidence of spinal metastases suggested that the dorsal lymphatic system might be responsible for the quickness of the spread. Examination of the spine in several other cases supported this view. The rôle of infection in increasing the seriousness of the prognosis, and in apparently stimulating the growth of tumour cells, was noted in several of these patients.

Section 6.—Probably no other section was as interesting as this one in demonstrating the importance of the three factors mentioned above. The mechanical factor alone was responsible for symptoms and pathology in a few of the cases of *carcinoma of the prostate*. The infective factor when present was extremely serious, as ascending urinary-tract infection usually supervened sooner or later. Dissemination was widespread in several patients, and the clinical picture was sometimes dominated by distant secondary growths. Widespread skeletal invasion occurred in a few patients, and was accompanied by masses of new growth in the upper dorsal region of the thoracic cavity, and by invasion of the tracheo-bronchial glands. An attempt to find the route of this dissemination led to a conception of the rôle of the dorsal spinal lymph path which is discussed later.

Seven patients having *carcinoma of the bladder* had no spread beyond the bladder, but infection had led to fatal urinary sepsis, and emphasized the importance of the infective factor relative to anatomical situation.

Section 7.—A widespread dissemination similar to that in some of the prostatic cases was found in several of the patients having *carcinoma of the cervix*. Infection of the primary growth produced pitiful and repulsive clinical pictures; while the indiscriminate invasion of tissues by the primary growth led to vesicovaginal and rectovaginal fistulæ with secondary infections.

Section 8.—The cases resembled those included in the other sections.

CONCLUSIONS.

Examination of the evidence provided by the 700 cases on which this paper is founded leads to the following conclusions :—

1. The mechanical and infective conditions associated with the primary growth are responsible for the greater proportion of the symptoms and of the deaths occurring in these patients.

2. Apart from these mechanical and infective conditions the gravity of the case appears to have a definite relationship to the distance between the mediastinal lymphatic system, particularly the tracheo-bronchial lymph-glands, and the lymphatics of the primary growth.

3. In the absence of mechanical and infective complications, all varieties of carcinoma tend to give rise to widespread metastases, and the most important route for the spread of the carcinoma cell is the lymphatic system. This system, while providing a path for dissemination, tends to localize the tumour cells within its own boundaries.

4. Evidence was found proving the existence of a dorsal spinal lymphatic path which is responsible for much of the widespread dissemination found in advanced cases.

1. **Mechanical and Infective Conditions.**—The pathology and treatment of these conditions differ in only one respect from those which are common to the mechanical and infective processes occurring in other diseases. The mechanical changes occurring, for example, as a result of carcinoma of the colon closely resemble those occurring as a result of the fibrosis accompanying a diverticulitis. The humoral defence of the organism, consisting of the various antibodies, is the same in carcinomatous ulcers as in other infected breaches of body surface. The cellular changes which are present in carcinomatous ulcers differ, however, from those which occur in other chronic ulcers because of the presence of a destructive factor—namely, the carcinoma cell. The other cellular changes may give rise to a marked degree of fibrosis, but the combination of the malignant cell with the infection leads to a gradually extending non-healing area and appears to increase the disseminating properties of the malignant cells.

2. **The Relation of the Primary Growth to the Mediastinal Lymphatic System.**—Examination of these cases justifies the conclusion that involvement of the mediastinal glands tends to occur in all patients suffering from carcinoma. The main spread of the carcinoma cell being by the lymphatic system makes the direct anatomical relationship between the primary growth and the mediastinal lymphatics of less importance than the distance by the lymphatic vessels. The obstruction of lymph-flow as a result of metastases in the glands may lead to the opening up of new paths between the affected areas of the body and the mediastinal lymphatics ; and the development of intrathoracic metastases as a result of these new routes may produce perplexing clinical pictures. Involvement of the tracheo-bronchial lymphatic system has been shown to result in very serious changes in the lungs, and an exceedingly grave prognosis is justified in all patients who have recent respiratory symptoms. The metastases in the liver are serious, not only on account of the difficulties in treatment, but also because of the important linking-up

between the capsular lymphatics with the mediastinal vessels, and the relatively early involvement of the tracheo-bronchial glands which results from these communications.

3. **The Rôle of the Lymphatic System in the Dissemination.**—The data obtained from a study of the 700 cases were based chiefly on macroscopic findings, and therefore no conclusions as to the relative importance of lymphatic permeation or of lymphatic emboli would be justified.

A large number of autopsies showed an indiscriminate invasion of surrounding tissues taking place in all directions from the primary growth. The spread along the lymph-vessels appeared to take place chiefly in the direction of the normal lymph-flow; but in several cases there was evidence pointing to an alteration of lymph-flow as a result of obstructive changes in the lymph-glands. Dilated lymph-vessels were most frequently found in relation with the lumbar vessels leading from the aorta to the tissues of the back; and the degree of dilatation appeared to correspond to the extent of the metastatic involvement of the abdominal glands, especially those lying near the upper part of the abdomen. The dilatation in most cases appeared to be a simple compensatory process which provided new channels for the lymph-flow from the abdominal cavity, but in a few cases some of these dilated vessels were found to consist of permeated lymph cords. This formation of additional or alternative lymph routes may therefore offer new paths for the dissemination of carcinoma cells.

The tendency to restrict carcinoma cells within the boundaries of the lymphatic system was very obvious in many of the examinations of cases of abdominal carcinoma. Large hard abdominal lymph-glands, connected by a dense network of enlarged permeated lymph-vessels forming a covering around and compressing the main blood-vessels, were encountered frequently in these examinations, but macroscopic invasion of surrounding tissues was rarely seen. Even in advanced cases infiltration of surrounding structures from these lymphatic deposits appeared to occur only when infective changes or necrosis due to expansion within a gland had altered the structure of the lymph-gland. Internal indiscriminate invasion of tissues appeared to occur to any extent only in bone, liver, and lung tissue.

2. **The Posterior or Dorsal Spinal Path.**—The discovery of plaques of new growth on the deep surface of the spinal laminæ and ligamenta subflava which occurred in a patient having a primary growth in the prostate, led to the suggestion of an intraspinous path for dissemination of carcinoma. Later autopsies have modified this view and have pointed to the existence of a much larger lymphatic path in the back. This dorsal path may not be important in the normal lymph drainage of the body, but may become prominent in the event of blockage of the intra-abdominal lymph-vessels. (*Fig.* 423.)

This dorsal path is considered to consist of the lymph-vessels lying deep to the lumbodorsal fascia as well as the vessels of this fascia. The lymphatic vessels lying in the erector spinæ muscles, and the lymph spaces present between the elastic and fibrous tissues which make up the connecting ligaments of the spinal laminæ, form an important part of this dorsal lymphatic system. Sections across the laminæ suggest the presence of lymph channels

lying in relation to their intraspinal surfaces; and one case in particular showed the presence of what appeared to be large lymph-vessels full of carcinoma cells in this situation.

The suggestion advanced as a result of the study of many post-mortem examinations is that this dorsal spinal system is responsible for many of the
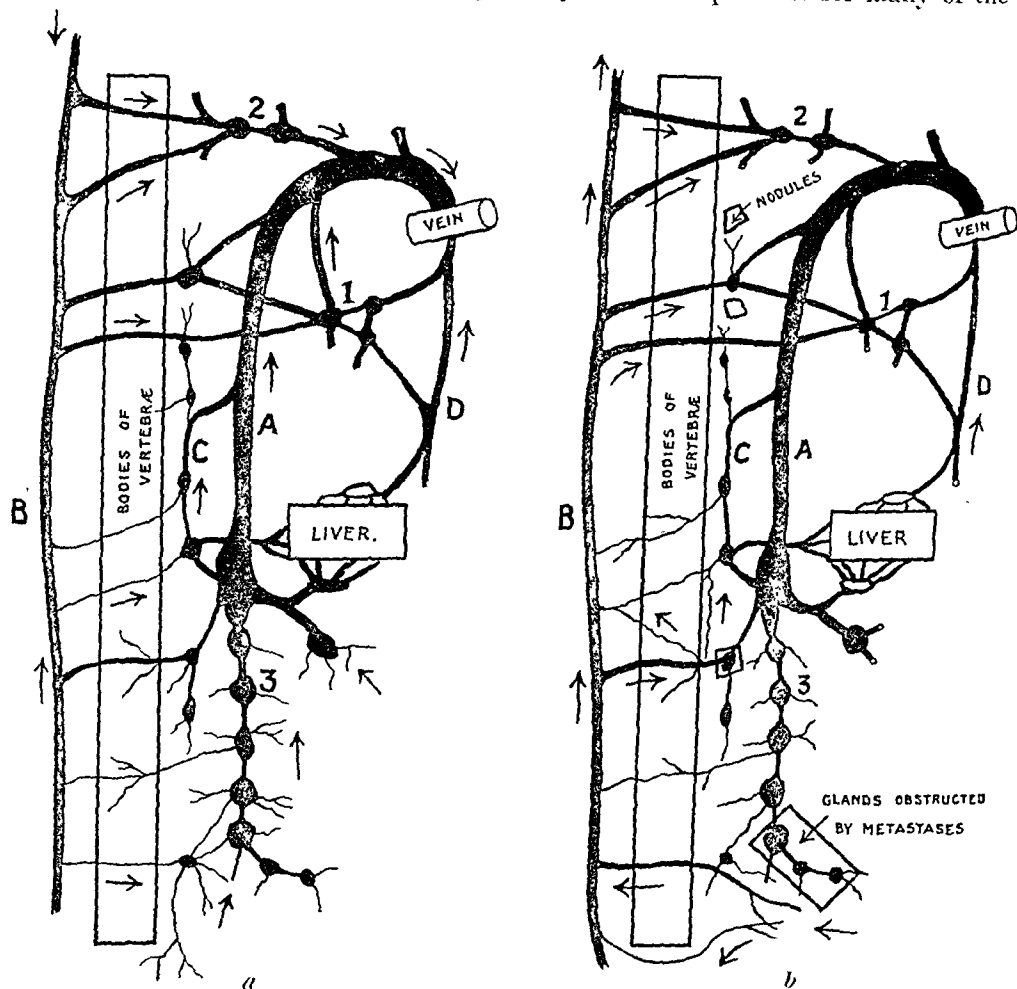
FIG. 423.—Diagrams of lymphatic systems. *a*, Normal lymph-flow. *b*, Suggested flow in carcinoma of the prostate with obstruction of the lower abdominal glands. Obstruction of any gland may lead to reversal of lymph-flow and the opening up of new paths for dissemination of carcinoma cells. 1, Tracheo-bronchial glands; 2, Supra-clavicular glands; 3, Abdominal glands. A, Chief anterior lymph system; B, Dorsal spinal system; C, Posterior mediastinal lymphatics; D. Anterior mediastinal lymphatics.

widespread metastases found in all varieties of carcinoma. This dorsal lymphatic system links up the sacral with the cervical regions, and it is suggested that vessels acting as anastomosing channels linking up the intra-thoracic and intra-abdominal systems with the dorsal system pass to the back in relation with the dorsal branches of the lateral arteries from the aorta. There is strong evidence in favour of the presence of large communicating

vessels at two levels : (1) At the upper dorsal region, particularly near the fourth dorsal vertebra ; and (2) At the level of the second lumbar region near the right renal vessels. The frequency with which masses of new growth have been found near bodies of the upper dorsal vertebræ, and the frequency with which the glands lying near the right renal vessels have been found enlarged in different varieties of carcinoma, suggest an anatomical cause for these metastases.

Communication between the main lymphatic vessels and the dorsal system may occur at any level—for example, if the lower para-aortic glands became obstructed as a result of invasion by carcinoma cells from the prostate, channels may dilate in the pelvis and pass through the anterior sacral foramina and thus lead to permeation of the vessels in relation with the laminæ, and ultimately reach the upper dorsal region, giving rise to intrathoracic metastases. Metastases, or operation, causing obstruction of the axillary glands, may lead to involvement of this dorsal path from a breast tumour, and metastases may develop in the pelvis or lumbar vertebræ. etc.

A suggestive anatomical consideration in relation with this dorsal path is the fact that the supraclavicular glands normally drain the lymphatics of the back.

SUMMARY OF THE CONCLUSIONS.

The importance of mechanical and infective conditions associated with the malignant tumours is emphasized.

The lymphatic system not only offers a path for dissemination of the tumour cells, but also tends to localize the malignant cells within its own boundaries.

There is a dorsal lymphatic system which plays a very important part in the spread of carcinoma cells and which may be responsible for widespread dissemination.

APPENDIX.

THE ANATOMY OF THE TRACHEO-BRONCHIAL LYMPH-GLANDS.

(After Poirier.)

These glands are subdivided into four groups :—

1. *The Right Para-tracheo-bronchial Glands.*—These glands are situated in the angle between the trachea and the right bronchus. Anteriorly they are in relation to the superior vena cava ; internally is the trachea ; externally the right lung ; and inferiorly the right bronchus, the right pulmonary artery, and the vena azygos major.

2. *The Left Para-tracheo-bronchial Glands.*—These lie close to the trachea and left bronchus and have the following relations : anteriorly, the ascending aorta ; internally, the trachea ; externally, the left lung ; inferiorly, the left bronchus and the left pulmonary artery.

3. *The Intertracheo-bronchial Glands.*—These are placed in the angle of bifurcation of the trachea. Their relations are : superiorly, the trachea ; anteriorly, the pericardium (one of these glands according to Baréty has a

lymph channel opening directly into the left auricle); posteriorly, the œsophagus.

4. *The Interbronchial Glands.*—These are buried in the hilum of the lung and lie in the angles of division of the larger bronchi. These glands are in *intimate* relation with the branches of the pulmonary vessels.

The interbronchial glands receive afferents from the superficial as well as the deep collecting trunks from the lung and visceral pleura. The inter-tracheo-bronchial glands receive afferents from the neighbouring structures, and particularly—from the point of view of malignant disease—from the œsophagus. The lymphatics from the œsophagus are in communication with the posterior mediastinal glands, which receive afferent branches draining the posterior intercostal glands and intercostal spaces. These œsophageal vessels also receive branches from the middle group of diaphragmatic glands which drain the middle portion of the diaphragm and therefore communicate with the lymph-vessels of the capsule of the liver.

The right and left para-tracheo-bronchial glands have communications with the lymph-vessels which accompany the internal mammary vessels, the phrenic nerve, and also the great vessels in the superior mediastinum.

The communications existing between the abdominal lymphatic system and the vessels of the anterior and posterior mediastinum offer a path by which the tracheo-bronchial glands may become invaded from carcinoma occurring in the abdomen.

It is interesting to note that the internal mammary lymph-trunks may open directly into the subclavian veins, and thus may provide a new channel for lymph from the thorax, abdomen, and lower limbs in the event of gradual occlusion of the normal channels.

SHORT NOTES OF RARE OR OBSCURE CASES

CASE OF DOUBLE TONGUE.

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WHILST cases of bifid and tri-lobed tongues have been frequently quoted in the literature, only three cases of double tongue can be found, so that a further example of this congenital anomaly, which is not so easy to explain on embryological grounds, seems worthy of record.

HISTORY.—J. B., a female, was first seen when one month old. The history was that birth was normal, but the nurse had noted that the child apparently had two tongues, which caused considerable difficulty in suckling. The child's mother had a congenital dislocation of the hip, but there was no abnormality of mouth or tongue in either parent. The child was brought to the Bristol General Hospital by its mother because it had frequent choking attacks.

ON EXAMINATION. — The patient was found to be rather a puny baby, weighing 7½ lb. A careful examination of the mouth failed to reveal any abnormality. The region of the nasopharynx was explored with the finger, but nothing abnormal was detected. The history given by the mother of attacks of difficulty with respiration and of a swelling appearing from time to time

FIG. 424.—Double tongue. The lower figure shows the accessory organ drawn to half scale.

in the mouth was so clear and definite that it was thought advisable to admit the child for observation.

Shortly after admission the child had a fit of coughing. When its mouth was opened a most extraordinary condition was found, for lying on top of the tongue was a second smaller one (*Fig. 424*). This was at once seized

with a pair of forceps and pulled forwards. It was found to be attached by a pedicle to the extreme base of the tongue. The pedicle was immediately transfixed and the accessory tongue removed. It is clear that at the time of the first examination this accessory tongue had fallen back into the larynx and was missed by the examining finger.

On examination its appearance was found to resemble exactly a tongue, with a well-marked median raphé. On section it was seen to be covered with squamous epithelium, possessing a core of connective and muscular tissue. The muscular tissue was striped and was found to run in two planes. Its structure was quite simple and closely resembled that of a fœtal tongue. The general appearance and microscopic structure indicated that it was a congenital anomaly rather than any form of benign new growth.

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ANEURYSM OF THE SPLENIC ARTERY.

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ONE night in April, 1929, a woman of 69 retired to bed feeling perfectly well and contented after a dinner composed largely of lobster. She was awakened about 4 a.m. with violent pain which was felt mainly in the left upper quadrant of the abdomen. She vomited and felt an intense desire to defæcate. Thinking that the lobster was to blame she took a vegetable laxative pill, but no action of the bowels could be obtained even after four attempts, although the desire was still present. The pain continued and the vomiting became incessant. I was asked to see her about 9 a.m., when she looked in danger of imminent death. The temperature was 97°, and a pulse of 120 was hardly perceptible at the wrist. The shock, the character of the pain, the inability to pass either fæces or flatus, and the persistent and progressive nature of the vomiting pointed to a diagnosis of acute intestinal obstruction.

On following my invariable practice of examining all acute abdominal cases with a stethoscope, I heard in the left hypochondrium, and only there, a sound which could have been nothing else than the bruit of an aneurysm. A careful examination showed that the thoracic aorta was free from blame. On leaving the patient's room I asked the practitioner to listen to the upper abdomen, being careful to give him no hint of what I wished him to hear. When he rejoined me he asked, " What can it be ? " I replied that it must be an aneurysm of the splenic artery which had ruptured.

Operation was decided upon and ¼ gr. of morphia was administered hypodermically. Within a few minutes the patient was free from pain and was pink and warm ; the vomiting ceased at once, and the pulse was 90 and of good volume. This reaction to the drug seemed so like that of a case of acute obstruction that I wavered in sticking to what appeared such an outrageous diagnosis. I ordered an enema, and since there was no result I finally

made the diagnosis of acute intestinal obstruction due to a vascular growth of the splenic flexure in which I had heard a souffle.

When the patient was placed on the operating table, the anæsthetist, who had been told the physical signs, was asked to listen. After a careful examination he turned round and with an indulgent smile told us that there was nothing to hear. The doctor and I both listened again and the bruit had completely disappeared.

The abdomen was opened through a split rectus incision extending downwards from the tip of the ninth left costal cartilage. There was no free fluid in the general peritoneal cavity. There was no growth anywhere, but the whole of the intestine, both large and small, was in a state of marked spastic contracture. On gently exploring the region of the spleen about a pint of blood-clot escaped from the splenic pedicle. Splenectomy was performed and all bleeding was thereby controlled. The abdomen was then closed. The spleen when seen within the abdomen was very small and showed a dark blue colour beneath a pale white anæmic capsule. No aneurysm sac was seen, since the tissues of the splenic pedicle were so ploughed up by the hæmorrhage that any differentiation of the vessels in that situation was impossible.

After a very stormy convalescence due to an extensive massive post-operative collapse of the lung on the left side, the patient recovered and is now—ten months later—in as good health as before the illness.

Before commenting on this case it seems worth while to recount the history of a case seen in 1913 of which I have still some rough notes, for it was a recollection of this instance which influenced my line of thought in the present case.

" A man was admitted to a medical ward for a sudden attack of acute abdominal pain. The diagnosis was obscure and he was treated on expectant lines with rest and morphia. About two weeks later he was suddenly seized with violent abdominal pain, vomited, passed blood by the bowel, and died in an hour. The post-mortem revealed an aneurysm of the splenic artery which had ruptured secondarily into the large intestine."

These two cases, with the one reported by Anderson and Gray[1], indicate a fairly definite course which may be expected in cases of aneurysm of the splenic artery and give some measure of hope of success in treatment. A primary rupture takes place into the lesser sac or the splenic pedicle. This is not usually fatal, since clotting occurs in a short time, as is evidenced by the loss of the bruit which was noticed in the case here reported. Later, after an interval of two or three weeks, the secondary rupture takes place, with a rapidly fatal termination.

This case illustrates only one instance of the very great value of abdominal auscultation in acute conditions. If I had not heard the bruit, my patient would probably have been opened by a median sub-umbilical incision. Nothing would have been found, and she would have been closed, to await death from a secondary rupture some days later.

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MIDDLE CEREBRAL EMBOLISM FOLLOWING PARTIAL THYROIDECTOMY FOR GRAVES' DISEASE.*

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WHILE post-operative embolism not infrequently occurs in the pulmonary circulation and becomes manifest either as an infarction of the lung or, if more massive, as an obstruction to one of the main branches of the pulmonary artery, it is less frequently met with in the systemic circulation. The following, however, is an example subsequent to partial thyroidectomy performed for exophthalmic goitre with auricular fibrillation. The embolism, which occurred on the eleventh day after operation, coincided with the return of auricular systole, and apparently occluded the stem of the left middle cerebral artery. The patient eventually made a good recovery both from the exophthalmic goitre and the distressing complication.

HISTORY.—A charwoman, age 54, was referred by Dr. Ivor Davies to the Medical Unit and subsequently transferred to the Surgical Unit for operation. She was a typical case of old-standing true exophthalmic goitre with auricular fibrillation, and prior to operation was treated with Lugol's iodine solution.

OPERATION.—On Sept. 19, 1929, under novocain analgesia, bilateral partial thyroidectomy was performed, leaving only a strip of thyroid tissue in front of the hilus of each lateral lobe. At the time of operation the pulse-rate was about 108, and afterwards there was a slight acceleration to 136. The pulse remained irregularly irregular. For a week before operation and for five days afterwards she was given Nativelle's digitalin granules.

SUBSEQUENT HISTORY.—On the eleventh day after operation, when the pulse-rate had fallen to 62 and become regular, she suddenly developed right hemiplegia, incontinence of urine and fæces, and aphasia. The hemiplegia was at first flaccid in type, but later became very slightly spastic. A sound something like a muttered 'no' was the only expression to which she occasionally gave voice. At times she appeared able to recognize objects and their use and to be attempting to talk, but was quite unable to, while at other times she could not mutter, and appeared oblivious of her surroundings. A diagnosis of embolism in the main trunk of the left middle cerebral artery was made, the non-spastic hemiplegia with aphasia suggesting a cortical rather than a capsular lesion.

Three days after the onset of the hemiplegia there was slight return of movement in the right arm and leg, but she was still unable to speak. Three days later, however, the arm movements were more complete and the leg could be flexed at the hip and knee. Both plantar reflexes were flexor in

type. There was slight weakness of the right side of the face. Three weeks later, at the time of her discharge from hospital, she was able to walk and use her arm, and she could speak, although imperfectly.

Commentary.—Although it seems reasonable to expect a tendency to embolism by the dislodgement of thrombi formed in fibrillating auricles when the resumption of normal auricular systole takes place, and emboli following the restoration of a regular rhythm in cases of auricular fibrillation treated only by quinidine and other drugs have been recorded by Wilson and Hermann,[1] Frey,[2] Benjamin and von Kapff,[3] Ellis and Clarke Kennedy,[4] and others, cerebral embolism is apparently a very rare complication of operation for Graves' disease.*

In the case here reported the relief of the condition by operation, and not the operation itself, must be looked upon as the cause of the embolism, the production of a slower and regular cardiac rhythm resulting in the liberation of the thrombus.

The site of the obstruction was presumably the left middle cerebral artery at its division in the Sylvian fissure into its infero-external frontal branch to Broca's convolution, and its ascending frontal branch to the precentral gyrus, and the cutting off of the blood-supply to these areas resulted in aphasia and hemiplegia. As the middle cerebral artery enters the Sylvian fissure it is much the largest of the terminal branches of the internal carotid, and appears to be the continuation of the parent trunk, so that emboli in the internal carotid tend to pass into and along the middle cerebral until obstructed at its division. It is well known that emboli leaving the heart by the aorta more frequently pass to the left middle cerebral artery because of the more direct course of the blood-stream in the left common carotid artery than in the innominate and right carotid systems, which are slightly directed away from the line of the blood-stream in the aorta.

The patient's recovery is now almost complete, the pulse is 72 and regular, tremors have disappeared, and there has been improvement in the exophthalmos, which is now much less apparent. She can walk and use her arm quite well, and although speech is not yet very fluent, it is daily improving.

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* Some idea of the rarity can be gathered from the fact that Sir James Berry from his extensive experience writes in a personal communication, "I have never met with any case of cerebral embolism as a post-operative complication of any thyroid operation", and although from his experience of over two thousand thyroid operations Mr. T. P. Dunhill tells me of three cases, of these two had had several attacks, one of them having suffered from emboli both before and after operation. The other case occurred fifteen days after operation and was fatal twenty-two days later.

PERSISTENT HÆMATURIA
FROM A MINUTE PAPILLOMA OF THE RENAL PELVIS.

By JAMES C. ANDERSON,

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THE following case would almost certainly have been classed as one of 'essential hæmaturia' if the bleeding had not been so copious and persistent as to necessitate operation. It is more than probable that, had a nephrectomy not been performed, this minute growth would have been overlooked, even though the kidney had been split in two. The same may be said of any very small lesion of the renal pelvis, such as small nævi or very early tubercle. In this particular instance, no apology is offered for such drastic procedure as removal of the kidney, since, as far as we know, such papillomata of the kidney pelvis eventually become malignant.

The patient, a robust, healthy adult, age 33 years, a clerk by occupation, was sent to me by Dr. A. M. Duthie, D.S.O., M.C., from New Whittington.

HISTORY.—On the morning of Feb. 23, 1929, he performed vigorous physical exercises; an hour later he was alarmed to see that his urine was deeply blood-stained. This symptomless hæmaturia persisted, but gradually became less in amount during the ensuing week, at the end of which his urine was but 'slightly turgid'. On March 1, after dancing, the copious hæmaturia reappeared. It tailed off until, on the morning of March 3, his urine appeared to be absolutely clear, but a long walk on this day caused the hæmaturia to reappear before night; this is the only occasion, prior to removal of the patient's left kidney, on which his urine was known to be free from visible blood.

ON EXAMINATION.—I saw him on March 7. His urine was like port wine in colour and there were no other symptoms or physical signs. The urine contained red-blood corpuscles, but presented no other physical or chemical abnormality. Radiological examination disclosed a chain of shadows on the left side of the pelvis, but subsequent pyelography showed that they were not in the line of the ureter. Cystoscopic examination showed rhythmic jets of blood issuing from the left ureteric orifice. Intravenous indigo-carmine appeared from the right ureter in three and a half minutes, and at the same moment the blood from the left side became darker in colour. The kidneys were excreting the dye equally and normally. Pyelography showed a normal left renal pelvis. The patient's blood-pressure and blood non-protein nitrogen were low.

After absolute rest in bed for three weeks the hæmaturia persisted and cystoscopic findings were unchanged. Another two weeks in bed, followed by a further cystoscopic examination, confirmed the previous findings. The hæmaturia persisted.

OPERATION.—Having made a diagnosis of a villous papilloma of the renal pelvis, I decided to expose the patient's left kidney, and on April 30,
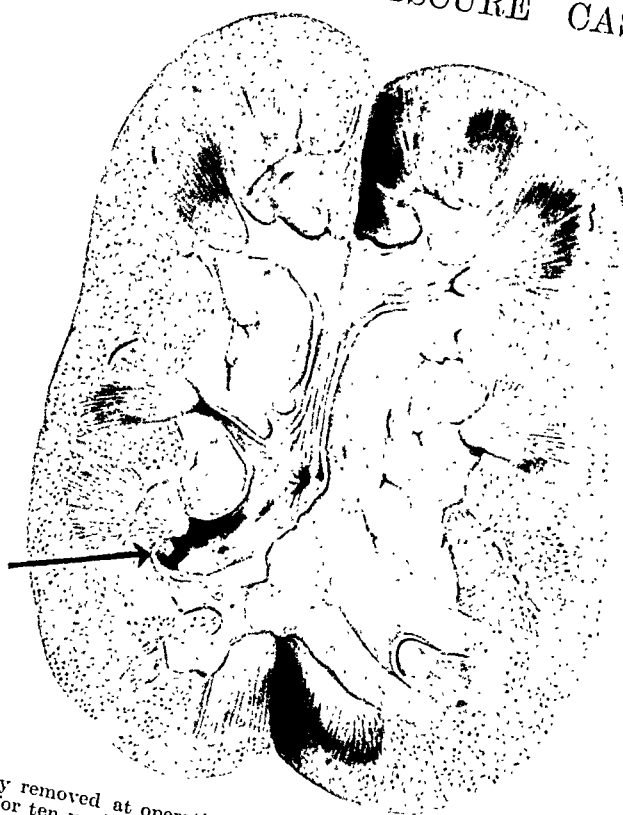
Fig. 425.—Kidney removed at operation. The arrow indicates a small villous papilloma responsible for ten weeks of persistent visible hæmaturia, one morning excepted.
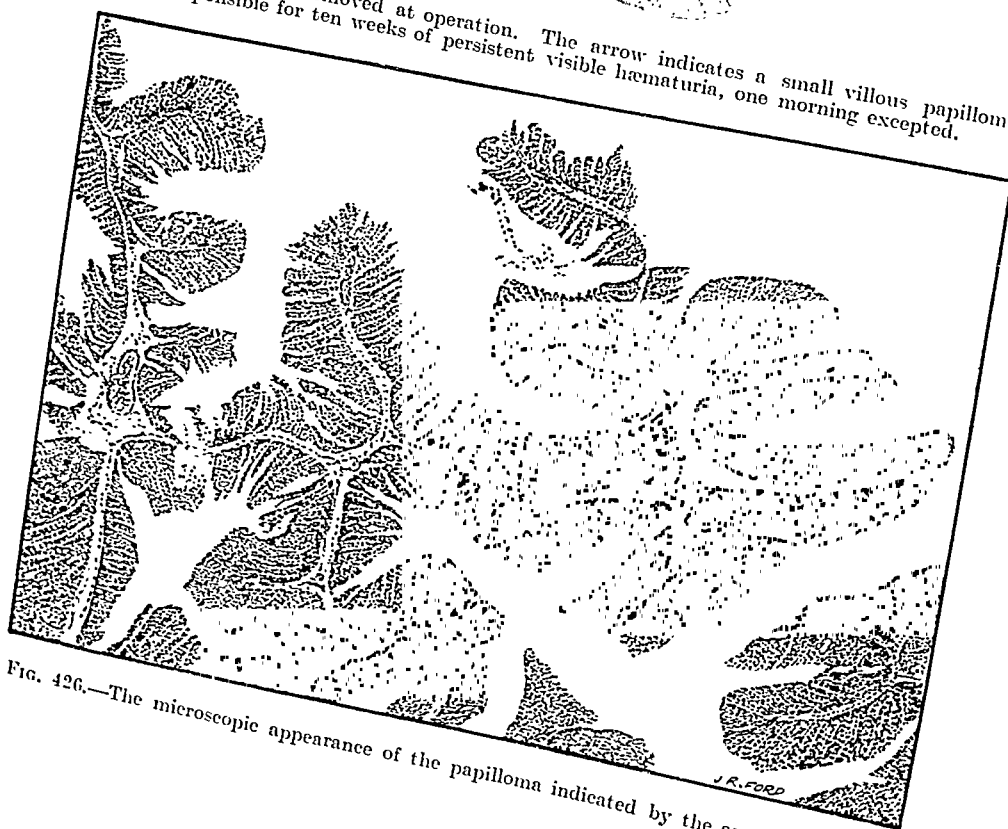
Fig. 426.—The microscopic appearance of the papilloma indicated by the arrow in Fig. 425.

after ten weeks of visible hæmaturia, one morning excepted, I removed an apparently normal kidney (*Fig.* 425). I failed to detect the small papilloma seen close to the apex of a renal papilla in the lowest calix (marked by arrow in diagram) and had sections made from several of the hæmorrhagic areas, thinking that these might be hæmangiomatous. They proved to be traumatic in origin. Fortunately, I showed the specimen to Mr. Graham Simpson and he located the papilloma, which was much less evident than the illustration might suggest. Microscopic sections confirmed the diagnosis of villous papilloma (*Fig.* 426). The hæmaturia ceased from the time of the operation and has not recurred since.

I have recorded this case because of the persistent and copious character of the hæmorrhage that came from such a small villous papilloma of the renal pelvis and because I believe it to be very rare, if not unique.

I am indebted to Mr. Graham Simpson, not only for finding the papilloma, but also for advice and assistance in publishing this case.

REVIEWS AND NOTICES OF BOOKS.

Gastric and Duodenal Ulcer. By Arthur F. Hurst, M.A., M.D. (Oxon.), F.R.C.P., Senior Physician, Guy's Hospital; and Matthew J. Stewart, M.B. (Glasgow), F.R.C.P., Professor of Pathology, University of Leeds; with the co-operation in the Radiological Sections of P. J. Briggs, M.A. (Cantab.), M.R.C.S., L.R.C.P., Radiologist to New Lodge Clinic and the ⁙ ⁙ ⁙ : ·' Clinic, Guy's Hospital. Crown 4to. Pp. 544 + xvii, with 159 ·· . .· ·· coloured plates. 1929. London: Humphrey Milford. 63s. net.

THIS book in respect of many of its parts is the best presentation in our language of a vast and difficult subject. It reflects great credit upon the industry and the learning of its authors ; and not less upon its publishers, for type and illustrations are very good. The new knowledge of this subject that has developed during the last quarter of a century is very largely the outcome of the labour of surgeons in this country and in America. Hypothesis and guess-work are being gradually displaced by real knowledge derived from inspection of parts by the surgeon, and by the correlation of discoveries made during operation with the history of the patient and with all laboratory findings. It is amusing now to recall the distrust amounting to frank disbelief with which physicians greeted the pioneer work of surgeons ; and it is worth while to remind ourselves of the debt owing to surgeons not only for their discoveries, but for their stern defence of what is now known to have been an impregnable position.

The historical section in this volume is admirable ; a full and most interesting survey of the whole progress of our knowledge is made. The work of Cruveilhier, regarded by many as the earliest of any value on this subject, is placed in true perspective, and its relation to the earlier work of Matthew Baillie, Abercrombie, and others, and to the almost contemporary work of that great physician and master of English prose, Brinton, is at last made plain. We have learnt much since in 1856 Cruveilhier laid down the dogma that a gastric ulcer could with safety be diagnosed in the presence of such clinical conditions as pain, vomiting, and hæmatemesis. Hurst's work, consolidating rather than creating opinion, dealing with the diatheses which make probable the development of a gastric or duodenal ulcer, is being corroborated by other observers ; and though it does not express the whole truth it affords a clue to a multitude of interesting problems. No one has more rightly or more successfully indicated the necessity for a full inquiry into all aspects of peptic ulceration than Hurst. The exact value of clinical inquiry, pathological investigation, radiological methods, and their value in association with one another are all admirably, lucidly, authoritatively discussed ; and the truth of the matter is freed from its ancient obscurities. The pathology of gastric ulcer is discussed by Stewart, who has done more than any other man to base our knowledge upon accurate investigation. His observations, made with great caution, as to the incidence of carcinoma upon ulcer, for example, are not always or generally accepted, but his position appears here as elsewhere to be so soundly based as to be irrefutable. It is not through lack of warm appreciation, but because of a desire to see the minor defects of a great work removed in future editions, that we propose to offer criticism.

Great hindrance to knowledge has been created in the past by too ready acceptance of post-mortem statistics. The authors do not yet perhaps realize that the material which reaches the post-mortem room is not to be regarded as affording

an average sample of the rest of the community; and that as was said long ago, "people do not often die in hospital from the chronic diseases from which they suffer during life". For example, it is here stated that because in 95·5 per cent of post-mortems a chronic ulcer of the stomach or duodenum is found, "it may therefore be assumed that about 10 per cent of all individuals suffer at some time in their lives from a chronic or duodenal ulcer". May we therefore assume that since a pregnant woman is rarely found on the post-mortem table, there are few births ?

A similar fallacy of drawing general conclusions from inadequate individual data occurs on page 291, where Nielsen's statistics are quoted. The total incidence of perforation of ulcers is asserted to be infrequent because among 182 patients of Faber's in whom an ulcer was diagnosed with a 'fair degree of certainty' between 1897 and 1915, 42 had undergone operation, but none for perforation. How many diagnoses of either gastric or duodenal ulcer made by any physician on the Continent of Europe between 1897 and 1915 were to be accepted with a 'fair degree of certainty' ? No one familiar with the literature or with medical or surgical clinical work on the Continent, which lagged far behind our own in vision and in accuracy, will find any difficulty in answering that question.

Again, on page 101 it is stated that in the post-mortem room duodenal ulcers and scars are equally common on the anterior and posterior walls, and that in Leeds nearly half the cases seen post mortem showed a lesion in both situations. No surgeon will agree that this is at all comparable to the conditions found during life.

The division of ulcers into acute, subacute, and chronic is needlessly complex. The term subacute in connection with ulceration was first used in connection with perforation. Here it was necessary, for there is a wide difference between the clinical symptoms and signs of the three degrees of perforation. A subacute ulcer is, however, nothing more than a brief stage between an acute and a chronic ulcer. The authors indeed say that it represents only a transition stage, probably short, and that ulcers in this stage are not often met with in the operating theatre or in the post-mortem room. It is clear that confusion exists in the minds of the authors, for it is stated in relation to the duodenum that there is "little doubt that many of the anterior-wall ulcers which perforate are in this transition stage." Nothing is more certain than that the great majority of duodenal ulcers which perforate have given rise to symptoms for months or years, and are, beyond any question, in the chronic stage, in spite of Nielsen's statistics which affirm that perforation is the first symptom in 10 per cent of cases. Many of Nielsen's cases, we feel sure, were not cases of ulcer, but of those various conditions which closely mimic the symptoms of ulceration, and with which Continental physicians are not closely acquainted. This is an example, of which there are many in the book, of expressions of opinion upon matters outside the province of the writers. A pathologist sees only the fatal cases of perforation and should not pass opinion on any but that small proportion : he cannot know what relation, so far as numbers are concerned, they bear to cases of ulcer.

The account of the symptoms of perforation of ulcers is not, we feel sure, written by an eye-witness. English literature already contains a description of perfect, even dramatic, accuracy of which the authors might with advantage have taken note. And certain of the old errors are repeated. In reviews of the excellent books of Mr. Zachary Cope we have protested against the inaccurate use of the word 'shock' as descriptive of the condition present in the early stages after perforation. We are told here that the pulse immediately after perforation is small, weak, and rapid. It most certainly is not. It is further stated that in the stage of reaction which comes on "in a few minutes or at most after two or three hours" the area of liver dullness diminishes owing to the escape of gas through the perforation. When will physicians realize that signs of peritonitis are not signs of perforation, and that when liver dullness is diminished the diagnosis of a catastrophe is too obvious for anyone to mistake it ? When will authors write of their own knowledge and observation and cease to copy once again the ancient errors ?

In discussing the differential diagnosis between a case of perforated ulcer and a case of acute pancreatitis, it is stated on page 297 that the tendency to obesity

in patients with the latter condition often helps the diagnosis. The tendency may be there, but it is hardly constant enough to be of value in diagnosis. In connection with subdiaphragmatic abscess, perforation of a gastric or duodenal ulcer is given as the commonest cause. We venture to think that appendicitis is a much more frequent cause.

The vexed question of the incidence of malignant degeneration in a gastric ulcer is considered very carefully, and the microscopic differentiation of ulcer-cancer and cancer-ulcer is discussed in great detail. Doubtful cases are rejected, and even then we arrive at 6·1 per cent incidence of carcinoma from ulcers or that in 15·7 per cent of cases of carcinoma the evidence points to their origin in ulcers. These figures are in marked contrast to MacCarthy's figures of 71 per cent and 68 per cent respectively, and although they are probably on the low side, as all doubtful cases have been rejected, they approximate more nearly to the truth. Even with this small number we have to ask ourselves whether medical treatment can ever justify itself. We all know how difficult it is to cure permanently a case of carcinoma of the stomach by operation, and medical treatment may be tried and valuable time lost during which the growth exceeds the bounds of operability. Purely medical treatment for chronic ulcer will apparently have a minimum mortality of 6·1 per cent, whereas purely surgical treatment in the hands of an expert has a mortality of about 3 per cent. A judicious combination of the two methods should give a slightly lower general mortality. The choosing of cases is one of the most difficult of tasks, and the most reliable guide which is given to us is that cases which do not quickly respond to medical treatment should forthwith be treated by operation. There is a further mortality also to be added from perforation or hæmorrhage occurring in cases during treatment.

One other criticism must be formally and earnestly made. A chapter is devoted to surgical treatment, and it is headed by a quotation from Bastedo, " The internist can refer his failures to the surgeon in good condition for operation, but in what condition does the surgical failure come to the internist ? " Is it possible for prejudice to go further ? Are the failures of the internist in good condition ? Are the cases of perforation, of hæmorrhage, and of obstruction—all or almost all of them failures of medical treatment—in good condition ? Are the cases of cancer following ulcer—the most inescapable of all disasters—favourable for operation ? The answer is evident. We regret that the authors should perpetuate so foolish a statement, and place it in a position of honour at the head of a chapter. Our objection to this chapter is based not only on surgical but on philosophical grounds. No physician is competent to appraise the exact .. · · · · · · : ., particular operation. When medical treatment has failed he must acknowledge it and leave the question as to whether an operation is necessary, as to which operation best meets the indications as he sees them, and as to the time of operation, to the only competent authority, the surgeon. This chapter is *ultra vires*. It bears only too plainly the evidence, throughout, of imperfect or pitifully inaccurate knowledge or apprehension of the points presenting themselves to the surgical mind.

The 'choice of operation' discussed here is not worthy of the writers and should be omitted in any future editions. There are no competent surgeons who would accept the arguments or agree with the conclusions here expressed. We are told that the pyloric vein is not a reliable guide to the pylorus, when as a matter of fact it is so consistently situated at the junction of the stomach and duodenum as to make a certain distinction of the two easily possible on inspection alone. The operation of gastroduodenostomy is severely criticized, and it is stated that both on clinical and theoretical grounds it should be abandoned. Theoretically it may be said not to carry the acid gastric ·contents away from the duodenum, but in practice it appears to give the most satisfactory results. It appears to be far less likely to be followed by anastomotic ulceration than a gastrojejunostomy, and for this reason alone is well worth a more extended trial than it has so far received. There are cases when it should not be performed, notably those in which there is some degree of chronic obstruction by the superior mesenteric vessels ; it may be that its performance in cases of this type is the cause of the clinical condemnation which is made. A criticism of this kind is recognized by those who know the

surgical side of the problem as a reflection not upon the operation but upon the knowledge and experience of the authors. *Ne sutor ultra crepidam.* Cholecyst-gastrostomy for ulcer is condemned, and it is stated that there is a considerable risk of cholecystitis developing, and that stomach contents do sometimes enter the gall-bladder. The former is a statement which is not supported by any confirmatory evidence, and as to the latter we know that if this does occur no harm results. Gastrojejunal ulcer is dealt with in a very full and exhaustive chapter. It is stated that it may arise many years after the performance of gastro-enterostomy, and although this is undoubtedly true, its incidence after the first eighteen months is decidedly uncommon. Many series of figures are quoted as to the proportion of cases in which it occurs, and a post-mortem series is here given which shows anasto-motic scarring or ulceration in 73 per cent of cases. The extent of this scarring is not indicated, and it is probable that the result of healing at the time of operation has been mistaken for the scarring of chronic ulceration. The authors admit that it is an excessive figure, but suggest that the true figure should be considerably in excess of the 1 to 2 per cent put forward by surgeons. The latest clinical figures by Luff show an incidence of 2·8 per cent. When we see the wide variation in these figures we are reminded of the adage that statistics can prove anything, even the truth. No doubt much depends upon the skill of the operator, and this is a factor difficult to express in statistical form.

We venture to think that the most important chapter in this book is concerned with medical treatment. Surgeons have long regarded their work as only comple-mentary to that of the physician. Were the physician's work adequately carried out by a loyal patient, fewer cases would come to operation. The medical treatment of patients, having regard to the whole country, is far too trivial and perfunctory. and has been shown by Moynihan—" a physician doomed to practise surgery "—to have far greater dangers than surgical treatment. The authors rightly urge a closer attention to the details of diet and drugs, and to a longer observance of neces-sary routine. We incline to think that even they underestimate the time necessary to accomplish healing. McLean, whose name does not appear in the chapter concerned with treatment, published details of cases in which X-ray pictures were supposed to show the healing of ulcers of moderate size in approximately three weeks. This statement was received with doubt and incredulity; for it was realized that an ulcer of the size depicted, if placed under most favourable conditions on the surface of the body, would never heal so rapidly; and we were reluctant to believe that in respect of rate of healing a gastric ulcer had advantages over all others. We think the stern ritual of Hurst is a far more effective method for the healing of ulcers than any yet advanced. The rather perfunctory method associated—quite inaccur-ately, as all acquainted with the literature know—with the name of McLean, who contributed nothing novel but his name, has in practice proved, in our judgement, very ineffective.

It may be that we are approaching the prophylactic period where we may warn people with the ulcer diathesis of the dangers they run, and put before them Bastedo's dictum—" a peptic ulcer will not develop in any individual who takes pains to secure a sufficient number of hours of sleep, to take plenty of time for his meals, to avoid indigestible food, to avoid the immoderate use of tobacco, and to make sure he is not harbouring any foci of infection "! An ulcer, that is to say, will not develop if an individual lives a life different from that of most ordinary people!

The volume is well written in spite of one or two lapses, as in the text under Plate 11, where a patient is referred to as having perforated, when obviously it is the ulcer which is meant, and the title of Chapter VI, which should be ·Hourglass Stomach'. It is not the contraction which is hourglass, but the stomach.

This is undoubtedly a book of reference with which every consultant should be familiar, and which everyone who is interested in the diagnosis and medical treatment of ulcers should read. Those parts which deal with pathology and diagnosis are excellent. Indeed, the only section of the book which we cannot welcome is that which deals with surgical questions, upon which neither of the distinguished authors can be regarded as an authority.

Rendiconto Clinico-operativo. Edited by Dr. G. Nogara and Dr. G. Pozzi. Super royal 8vo. Pp. 929 + xxxii, with 61 illustrations. 1929. Milan : Poligrafica degli Operai.

THIS handsome volume contains the Reports of the Institute of Clinical Surgery of the University of Milan for the years I to VI of the Fascist era. So full and complete an account of the whole 9556 cases treated in those years is made possible by the munificence of a citizen of Milan equally appreciative of the glory of the epoch. It is impossible to 'review' such a mass of material, but it may be said at once that as a work of reference for statistical purposes it should be a mine of wealth. It includes, apparently, every case treated in Professor Baldo Rossi's service, and though there are many contributors to the various sections, which are regionally arranged, one spirit and one method characterize the whole. A general section of fifty pages by Dr. Nogara details the methods employed for the investigation and control of diabetics needing operation ; for the estimation of the efficiency of the respiratory, circulatory, uropoietic, and hepatic functions ; for investigating the blood values and for performing transfusion ; for inducing anæsthesia, and so on. Spinal anæsthesia is much employed (30,000 cases in about twenty-five years), preferably with a mixture of stovaine and novocain. They note that when used for operations above the umbilicus collapse is apt to occur about fifteen or twenty minutes after injection. The accidents met with have been transient and comparatively trivial. In the section on the head very detailed reports are given of fourteen cerebral tumours and of several exceptional tumours elsewhere, such as a cystic adamantinoma of the jaw, and rare growths of or associated with the salivary glands. Such reports throughout are made the basis of extensive discussions of the pathology, diagnosis, and treatment of similar cases from the literature.

Thoracic surgery, whilst not extensively practised, extends to all the types of lesion nowadays submitted to operation. Of the value of radium used after operation for cancer of the breast no estimate is at present expressed. It is interesting to see the trend of opinion in still another clinic towards dissatisfaction with gastro-enterostomy for ulcer, and to note that, as elsewhere, the end-results of gastrectomy for cancer are very disappointing. A patient with sarcoma of the stomach operated on in 1922 is still alive and free from signs. A very ingenious detachable forceps is employed for resections.

Throughout the section on the urogenital organs and the rectum the records are such as correspond with practice and experience in this country. The sections on fractures are well illustrated, and expose a practice, evidently very efficacious, rarely operative, and dependent upon the skilled employment of traction and plaster-of-Paris. Professor Rossi himself has paid great attention to the methods and mechanics of this treatment and has inspired his assistants with his own assiduity. The radiographs of results bear eloquent witness to their success. Particular attention should be directed to the ambulatory method of treating fractures of the femur illustrated on pages 823–832, and to the simple method for operative fixation of the fragments in fracture of the neck on pages 847–854.

The bare mention of these few features of the book gives no idea of the amount of work involved in this publication or of the intensive study of their clinical material reflected in the pages written by the staff of the clinic. As a whole, and in all its parts, the volume throws the greatest credit upon the dominating figure of Professor Rossi and upon the band of admirable clinicians he has gathered about him.

Surgical Diseases of Children. A Modern Treatise on Pediatric Surgery. By SAMUEL WALTER KELLY, M.D., LL.D., F.A.C.S., Member of the Senior Staff, St. Luke's Hospital, Cleveland, Ohio. Two volumes. Third edition, revised and enlarged. Royal 8vo. Pp. 1374 + xiv, with 615 illustrations. 1929. London : Henry Kimpton. Two volumes, 63s. net.

THE fact that this is the third edition of Kelly's *Surgical Diseases of Children* testifies that the book has met with approval, and that it has occupied a prominent place in surgical literature. The present edition embraces two volumes, and the plan of arrangement is that the first volume deals with matters of general interest, while the second is devoted to what may be termed regional considerations.

The first volume is somewhat disappointing; it gives the reader the impression that it has not received the same amount of attention as has been devoted to Volume II, and there are numerous references to matters which seem scarcely relevant at the present time. The value of Volume I would have been enhanced if it had been submitted to some discrimin ' · · . ' . W have sympathy with the author in this matter; elimination is a . · · task, because so much of the context has established such a degree of familiarity that it seems to savour of treachery to abandon it, and yet, if successive editions are to maintain the standard of the original, replacement is inevitable. It is perhaps this criticism which explains certain figures tabulated on page 25 under the heading of anæsthetics, where it is recorded that the operation for double hernia in a child of fourteen months occupied one hour and forty minutes, and that pyloric stenosis in an infant of three months (a lesion presumably congenital) was treated by gastro-enterostomy, an operation of fifty minutes' duration.

The section on blood transfusion is helpful and inclusive, but it is a pity that no mention is made of immuno-transfusion. In discussing the biochemical aspects of post-operative acidosis it is stated that " the blood is acid, or, more correctly speaking, diminished in alkalinity, as shown by tl ' · ,;' ' · · ·,·l·th·l·i· test." This estimate is unlikely to be acceptable to the · ·

The introduction, comprising sixty pages of the book, is concerned with the " general surgical pathology of the developing period." It is difficult to understand the principle upon which this grouping is arranged, for it includes such widely differing conditions as acromegaly, hydatid cyst, chloroma, and tumours of bone. Taken as it stands, the information is moderately satisfying, though there are certain statements which demand challenge, such as " pressure on the chiasm produces optic neuritis "; " In cases of sarcoma of an extremity early and thorough removal may succeed in eradicating the trouble, but it is apt to be followed by recurrence necessitating final amputation "; and again, " The presence of Bence-Jones protein-uria confirms the diagnosis of sarcoma, or at least of myelogenous disease." These points are stated with dogmatic assurance, and yet it is obvious that they demand considerable qualification.

The second volume is a more satisfying production. It presents the surgical problems of childhood on a regional basis, and it does so in an inclusive and attractive way. Modern views have received due consideration, each subject is treated in logical sequence, and it is pleasant to find the author discussing his subject on a basis so essentially clinical and personal.

Even in Volume II, however, there is much which is open to criticism. Birth injury of the brachial plexus is discussed, and after a short description of the conservative treatment of this disability, Kennedy's operation is detailed and apparently supported by the author. The operation was described twenty-seven years ago; it implies exposure of the plexus, the excision of damaged nerve tissues, and end-to-end suture. The results have been uniformly disappointing, and it is doubtful if the method is ever practised at the present day. The real objections to the method are that, if nerve division has occurred, the site of rupture is so close to the spinal column that suture is impossible. while, if there is stretching without avulsion, conservatism offers better results than suture.

Poliomyelitis, a subject of such vast interest and importance in pediatric surgery, is unconvincingly treated. Recent research has shown that the three weeks' quarantine recommended by the author is insufficient. It is also probably incorrect to say that " it attacks the entire central nervous system and also its meninges." The statement that " there is said to be very little danger of death from this disease " is surely unduly optimistic, for epidemic types are often associated with a heavy mortality.

More careful proof-reading would have eliminated the unfortunate lines (page 725) " after the joint is opened with a knife, gouge, or Volkmann spoon, the cartilage or a portion of it is removed ". Soutter's operation for correction of flexion deformity of the hip is insufficiently and even incorrectly described.

The chapter dealing with the spinal column is unsatisfactory, and in future editions it would be well to revise in detail the pathology and treatment of scoliosis.

In discussing the treatment of congenital stenosis of the pylorus it is doubtful wisdom to allude at such length to the operation of gastro-enterostomy, and when the description includes the recommendation, " The anastomosis completed, a catheter may be passed per oreum through it, and a dose of water placed in the intestines before closing the abdomen ", we are inclined to doubt whether these volumes are as personal in their experience as we originally thought.

But let us have done with criticism ! It is a vast task to compile and to write thirteen hundred pages of description, and the author is to be congratulated on the success of much that he has accomplished. The binding, printing, and paper are excellent, many of the illustrations are good—some might with advantage be omitted and replaced by informative diagrams.

The Mobilization of Ankylosed Joints by Arthroplasty. By W. RUSSELL MACAUSLAND, M.D., Surgeon in Chief, Orthopedic Department, Carney Hospital ; and ANDREW R. MACAUSLAND, M.D., Orthopedic Surgeon, Carney Hospital, Boston, Mass. Medium 8vo. Pp. 252 + vii, with 154 engravings. 1929. Philadelphia : Lea & Febiger. $4.00 net.

THIS work collects in a small space an account of the methods of arthroplasty used by the authors and by pioneers in various countries. The attitude towards arthroplasty is, perhaps, rather an optimistic one. In spite of the statement in the Preface that arthroplasty has become a standardized form of treatment in the mobilization of ankylosed joints, one cannot but feel that in the case of most of the joints the work is still largely experimental in character, and that it is extremely difficult to foretell the functional result that will be obtained by operation in any individual case. But for this very reason, such a really extensive collection of literature, put together by surgeons who have also a large amount of practical experience themselves, is valuable.

If there is one criticism that may be made it is that perhaps insufficient attention is paid to the indications for arthroplasty in the case of each joint, and to the way in which the prognosis after operation is affected by the pre-operative condition. It is well known that the joints upon which it is best to perform an arthroplasty to obtain a good result are usually those with a sound ankylosis in a good position following some acute infection—just those cases in which most conservative surgeons are apt to advise the patient to leave the joint as it is. Arthroplasty is more difficult in cases of unsound fibrous ankylosis, and in cases in which there is a bad pre-existing deformity.

The work is very well written, printed, and illustrated, and will be used as a work of reference by those practising joint surgery.

Radium Practice, 1929. Edited by ROCK CARLING and the *Westminster Hospital Reports* (Vol. XXI) Editors, STANFORD CADE and DONALD PATERSON. Demy 8vo. Pp. 258 + viii, with 12 illustrations. 1929. London : H. K. Lewis & Co. Ltd. 7s. 6d. net.

THIS book outlines the current methods of radium treatment at the Westminster Hospital, and embodies the course given there in July, 1929, by the staff, nineteen of whom contribute to this volume. There is an excellent introduction to some physical aspects of radium, and the rest of the book is devoted to methods of application, with notes on the 'follow-up' cases shown, and the operations performed during the course.

That radium therapy during the last few years has made great progress is shown by the statement, made here by a surgeon, that even in operable cases of carcinoma of the tongue, radium will entirely obviate the necessity of excising the primary growth. This, moreover, is the trend of opinion expressed throughout the book, except in connection with the treatment of operable carcinomata of the rectum, where excision is still held to be the method of choice.

Now that radium is a definitely established part of the surgical armament, it is necessary to fix its true value, and this may be achieved best by comparing the considered opinions of groups of men engaged in radium therapy. This volume

emphasizes the value of team work, which is clearly illustrated by the descriptions of biochemical investigations employed to check the results of radiotherapy, and the importance of repeated blood-counts upon those who are exposed to irradiation. As the minimum screenage necessary for interstitial irradiation 0·5 mm. of platinum is accepted, and small doses of radium over a long period of time are considered to produce the best results, while radon, which is said to involve greater technical difficulty of uniform distribution, and with which it is suggested that it is necessary to commence with an overdose to obtain an adequate total dose, is not used. There is much in this book to interest both radium workers and surgeons, and the authors are to be congratulated upon the wise attitude of caution which they have adopted.

Regional Anæsthesia. Its Technique and Clinical Application. By GASTON LABAT, M.D., Clinical Professor of Surgery, New York University and Bellevue Hospital Medical College, etc. With a Foreword by WILLIAM J. MAYO, M.D. Second edition, revised. Royal 8vo. Pp. 567, with 367 original illustrations. London and Philadelphia: W. B. Saunders Co. 35s. net.

WE welcome a second edition of this book, which is probably the best work upon the subject of regional anæsthesia, and we prophesy a success for the new edition similar to that which attended the first appearance of the work. In it the surgeon, the first assistant, or the anæsthetist will find everything that is necessary for the successful practice of the art of regional anæsthesia.

In discussing the technique of splanchnic analgesia the author still prefers the posterior route first suggested by Kappis and modified by himself, regarding this method of access as the safest, simplest, and most certain. His experience hardly coincides with that of the Austro-German school, Finisterer, von Haberer, Clairmont and others all employing the anterior method of Braun ; and in those few English clinics where splanchnic anæsthesia is employed, either alone or with light general narcosis, the posterior method has now been abandoned and the anterior route is exclusively used.

In this second edition the chapter on spinal anæsthesia has been largely rewritten, and the writer appears now to exhibit a predilection for the subarachnoid block in cases where formerly he advocated regional or paravertebral anæsthesia, and in his opinion the subarachnoid block is indicated in all operations below the diaphragm, " when the other procedures of regional anæsthesia cannot be induced successfully or are likely to fail." In our view the use of regional anæsthesia and splanchnic block constitutes a far safer form of anæsthesia for upper abdominal cases, and is perhaps best utilized in conjunction with gas and oxygen or light general anæsthesia. In this way the Crile principle of 'anociation' is carried one step further forward, for the splanchnic block is but an additional form of regional anæsthesia.

The author employs novocain, or rather the French brand, néocaine ; our own recent experience with percaine has convinced us of its marked superiority over the drugs just mentioned, and for abdominal work it has been found that the analgesia produced with percaine lasts longer and is not associated with the fall of blood-pressure symptoms seen in cases where novocain has been the drug employed.

The illustrations are clearly delineated and most helpful, but a few of the recent additions are not quite up to the uniformly high standard of the rest of the figures.

Diseases of the Thyroid Gland. By ARTHUR E. HERTZLER, M.D., Surgeon to the Halsted Hospital. With a chapter on Hospital Management of Goiter Patients by VICTOR E. CHESKY, M.D., Associate Surgeon to Halsted Hospital. Second edition, entirely rewritten. Royal 8vo. Pp. 286, illustrated. 1929. London: Henry Kimpton. 32s. net.

IN the preface to the second edition of this book—which has been entirely rewritten —the author again emphasizes the statement that his isolation has enabled him to work untrammelled by the opinion of others, and has given him the opportunity of observing his patients over long periods, many of them for more than thirty years. The second reason is a sound one, and the book bears much evidence of its value ;

whether the first reason is as important as the author believes is open to doubt. The informed opinion of others is a healthy corrective to one's own ideas, and the statement itself is rather belied by the intimate knowledge shown of the most recent literature on the subject. One statement in the preface, that the chief difference in technique from that given in the first edition is that now 'no' partial resections are done, scarcely marches with that on page 70 about " fulminating cases which go on to a fatal termination before they can be prepared for operation ". The use of iodine has increased the safety of operation, and frequently this may be completed in one stage, but there are still many patients intermediate between those in whom this can be done and the fulminating cases where the author states that operation cannot be contemplated.

Apposite epigram and dogmatic statement make the book extremely entertaining, but these occasionally are built on half rather than whole truth. The work is modern in outlook. Leaving out of consideration for the moment malignant change, enlargements of the thyroid gland are regarded as one entity, the author frequently writing of 'the disease'. He emphasizes the fact that in most cases this is extremely chronic, and only those can arrive at fair conclusions who are able to observe their patients for long periods, or throughout the course of the disease. The study therefore is eminently one for the family doctor whose life is part of that of his patients. The author insists repeatedly on the tendency of the disease to advance from the comparatively innocent to the more serious forms, and in the classification adopted he states that these classes do not represent separate diseases, but merely stages—at least for the most part—of one progressive disease. " Naturally the change does not take place overnight, but may require years, even decades." This being so, it is not possible to regard an enlarged thyroid as negligible in its earlier stages. This does not mean that operation should be performed in the early stages, and due prominence is given to the fact that the simpler forms frequently respond to appropriate treatment. From thirty-five years' observation in the one district, Hertzler believes that a goitre which has not been cured early sooner or later kills the patient, unless some intercurrent disease anticipates this end. " Timely operation in goitre is as important as timely operation in cancer. Doping goitres of certain well recognizable types with medicine rivals in wisdom the application of salve in cancer of the breast." On the other hand, he indicates strongly the harm done in operating upon psychasthenic patients whose symptoms are not attributable to the thyroid.

The author well points out the infrequency of auricular fibrillation in young patients, even in severely toxic cases, while in those past middle life fibrillation is common with much less toxæmia. For the foregoing reasons he speaks in no uncertain voice about the wisdom of early and adequate operation once the disease is established, being convinced through living a long life in intimate association with his patients that this completely cures, and that the cure is incomplete only when operation has been delayed too long. In this respect the author states that the removal of an adequate amount of thyroid tissue is a relatively recent accomplishment. In American literature it is generally ignored that this was insisted upon in British literature in 1908, and repeatedly in the years immediately following. Notwithstanding the insistence placed on the single entity of the disease, Hertzler states that he agrees with Plummer that a sharp division should be made between true Basedow's disease and the supertoxic colloid goitre. This is scarcely in accord with the trend of modern thought, or indeed with the author's own views repeatedly expressed throughout the book. Everyone will agree in appreciating both the great service rendered to goitre surgeons by Henry Plummer, and the tribute paid to him by the author in dedicating the volume to him.

For toxic goitre hospital management (in a chapter by Dr. Chesky) and an operative technique are well described. Local anæsthesia is used almost exclusively at this clinic. Not everyone will agree that sharp dissection throughout is the wisest practice : and most surgeons now follow Lahey in using lateral in preference to median drainage. These are matters of individual preference. The incision illustrated to give easy approach to a unilateral goitre is never required ; any deviation from the collar incision gives a conspicuous scar. With regard to the

parathyroids the author states that "we pay no heed to these little glands, and we have no tetany." If this were the universal experience, surgeons who operate upon the thyroid gland would be relieved of one of their greatest anxieties.

The author believes that nine out of every ten cases of carcinoma of the thyroid gland develop from fœtal adenomas. The difficulties of diagnosis both histologically and clinically are well set forth, but it would not be safe to accept the statement that "for surgeons it is more convenient to regard those tumours as benign which, though showing microscopic evidence of malignancy, have not perforated the capsule." There have been too many instances where the subsequent history has confirmed the pathologist's judgement. Few will agree that "problems [of malignancy] must be settled at the operating table ; a study of slides alone cannot decide them." On study of the slides may depend the patient's life. Although the ultimate prognosis is bad, the author does not appear to realize the extent to which life may be prolonged in many instances by the use of X-ray treatment following operation, even when local spread has been extensive.

There is apparently no reference to the condition known as woody thyroid, or Riedel's struma. *Fig.* 52, taken from a patient with a B.M.R. of −3 and who was not improved by operation, is singularly like a section from the early stage of a woody thyroid. Apart from this, the subject is covered very thoroughly. The illustrations are numerous, well chosen, and well reproduced. These, together with the lucid style, make the author's meaning everywhere clear. On a subject embracing so many aspects which are still unsettled there must be differences of opinion ; bearing this in mind, the book is good, and it is extremely entertaining.

Stone in the Urinary Tract. By H. P. WINSBURY WHITE, M.B., Ch.B. Edin., F.R.C.S.E., F.R.C.S., Assistant Urological Surgeon, St. Paul's Hospital for Genito-urinary and Skin Diseases. Large 8vo. Pp. 344, with 181 illustrations in the text and 2 coloured plates. 1929. London : J. & A. Churchill. 25s. net.

MONOGRAPHS on this subject are not very common, and we looked forward to reading what the author had to say on stones in the urinary tract and their treatment. We may say at once that there is not very much new in this book, but that it contains an excellent and up-to-date account of our present knowledge of urinary stone. The illustrations are uniformly excellent and well reproduced ; indeed, the volume is quite worth buying if only for the beautiful pictures of stone in the kidney and ureter and for the skiagrams ; many of them would make first-rate lantern slides for purposes of lecturing.

The urological surgeon will naturally turn first to those parts of the book which deal with problems on which there is still some difference of opinion. Whilst the author has nothing original to give us on the theories of stone formation, there is a most interesting account of the actual process of formation in the kidney and ureter. He points out that stones tend to grow against the stream of urine ; thus if the nucleus of a stone lies in the pelvis of the kidney, the later extensions will grow into and fill the calices ; in the same way, the nucleus of a ureteric calculus will always be found at or near its lower end.

Another point of some practical importance is the significance of the cessation of growth in a kidney stone ; this the author looks on as a sign of ill omen, for it is probably due to the absence of any urinary excretion and means the destruction of the renal cortex. An even more striking statement is that "it is of value to remember that a kidney damaged by stone or by the operation necessary to remove it will resume its function if the other kidney is insufficient for any reason. If the other kidney is perfectly normal, the damaged one will not regain its function after operation." If this is true, and it sounds quite reasonable, nephrectomy for stone in the kidney should be performed much more often than it is : unfortunately, the author gives us nothing in the way of proof, and not even a reference in case we should feel inclined to look into this question a little more closely.

In the treatment of stone in the bladder Mr. Winsbury White is an ardent advocate of lithotrity—rightly so, we think, for the mortality is astonishingly low and this method of treatment is admirable from the point of view of the patient

and also from an economic standpoint ; we often wonder why the operation has not become more popular. However, the writer is so carried away by his enthusiasm for the crushing operation that he omits to give any description of suprapubic lithotomy, though he mentions that the choice has to be made between these two procedures.

There is a good index and a very extensive bibliography of everything published from 1910 to 1928, covering nearly seventy pages, and including English, American, French, German, Italian, Dutch, Russian, and Scandinavian sources ; this would be more useful to the general reader if it were provided with a separate index, especially one of the authors' names.

On the whole, we consider this a very useful monograph, and we commend it to our readers. For the benefit of future editions, we point out that on page 16 the reference to *Fig.* 160 should be altered to *Fig.* 162 ; on page 37 the figures referred to as 163 and 164 are obviously misnumbered ; on page 115 reference to *Fig.* 89 shows a huge ureteral stone, but no ureteral catheter pointing to it as one would expect from the text.

If it were possible to rearrange the book, it would add greatly to the comfort of readers if the illustrations could be made to face, at any rate roughly, the page on which they are referred to ; it is exasperating when reading page 189 on the treatment of vesical stone to have to turn back some thirty-nine pages to find *Fig.* 103 ; indeed, the reader is likely soon to cease to take the trouble to do so ; some of the figures might well be given twice.

Lastly, one other point which we approach with diffidence ; we think the author's habit of over-emphasis defeats itself ; one sentence is given as an example : " A well-lubricated *forefinger* slowly introduced into the *rectum* while *the other hand* gently compresses the *suprapubic region* ", etc. We humbly suggest that this irritating underlining does not allow sufficiently for the average reader's intelligence.

The Treatment of Varicose Veins of the Lower Extremities by Injections. By T. HENRY TREVES-BARBER, M.D., B.Sc.   Crown 8vo.   Pp. 120, illustrated.   1929. Bristol : John Wright & Sons Ltd.   6s. net.

So much has been written about the treatment by injections of varicose veins that in a new book on the subject one naturally looks for something new ; but apart from a description of a new needle and the use of an unusual solution, there seems nothing that is new in this book.

Under the heading of etiology the author classifies the causes into congenital, hereditary, and acquired ; whereas on the pathological side he divides varicose veins into three separate groups—namely, primary varicose veins, secondary or acquired varix, and dilated veins. The latter are purely symptomatic and are due to a compensatory circulation. The importance of deciding into which group veins fall before commencing treatment and giving a prognosis is emphasized. The importance and use of the 'breathing' test, in which the veins dilate on inspiration and contract on expiration, thus demonstrating the incompetency of the valves, is urged. In the chapter on complications of varicose veins we find it difficult to agree that talipes equinus is a not uncommon complication in long-standing cases of varicose veins.

The author favours the use of sodium chloride as a sclerosing agent. He uses a 15 or 20 per cent solution and gives up to 20 c.c. of the latter. He makes a good case for the use of this salt in preference to others. A needle with a lateral eye just proximal to the point is advised since it brings the solution more closely into contact with the endothelial lining of the vein, and by rotation the solution can be made to impinge on the whole circumference of the vein.

A chapter is devoted to varicose veins and puerperal septicæmia, and the author believes that not only is puerperal septicæmia a common cause of phlebitis, but also that it may originate from a phlebitis which has been present before the pregnancy.

The most obvious deficiency in the book is the absence of records of cases. If the author had given the numbers of cases cured, improved, or not in his own series, and if the numbers of cases of the various complications had been given, the value

of the work would be increased. Throughout the book a number of rare words such as lipothymia, anamnesis (a Continental term), saphenectomy, hæmatolytic, and epidermoplastic are used. Simplicity in the choice of words might be preferable.

The Injection Treatment of Varicose Veins. By A. H. DOUTHWAITE, M.D., F.R.C.P. (Lond.), Assistant Physician to Guy's Hospital. Fifth edition. Crown 8vo. Pp. 58 + x. 1929. London : H. K. Lewis & Co. Ltd. 4s. net.

WITHIN two years this little book has reached its fifth edition. A little has been added in each issue, and in the latest there is a new account of the microscopical changes produced by sclerosing solutions in a varicose vein. We are surprised to find that the author still advises that an enema should be given before injecting hæmorrhoids. We still feel, as in our review of the first edition, that it would be very helpful if the author gave fuller details and statistics of the results, complications, and failures in his series of cases, which should now be sufficient in number to record. The book is a simple introduction to the treatment by injection of varicose veins and can be recommended to the beginner ; but no account of the direction in which it is best to put the needle in the vein is given.

Hæmodynamics. The Mechanism of Venous, Capillary, and Lymphatic Flow ; Œdema ; and Injection Treatment of Varicose Veins. By P. B. KITTEL, F.R.C.S., Assistant Surgical Officer at the Royal Northern Hospital, London. Crown 8vo. Pp. 196 + xi, with 3 plates and other illustrations. 1929. London : H. K. Lewis & Co. Ltd. 10s. net.

A BOOK of nearly two hundred pages on a subject such as hæmodynamics seems rather formidable and at first unnecessary, but with the treatment of varicose veins by injection so much to the fore as it is at present it is important that all the phenomena of venous and capillary flow, of the action of valves, of compensatory dilatation, and of œdema should be understood. Many points about these subjects which are very clearly set out by the author from a simple physical point of view are realized for the first time.

The author's experience is gained from 446 cases of varicose veins. The last part of the book is devoted to treatment. After many cases had been treated with quinine and urethane, sodium salicylate, and saline borocaine, the author commenced using sodium morrhuate in a 5 or 10 per cent solution. By accident, when injecting the drug intravenously for tuberculosis, he found its sclerosing properties, and now prefers it to any other solution. He only refuses to treat varicose veins on two counts, decrepitude and swelling of the legs. He does not appear to rank phlebitis as a contra-indication to treatment by injection.

The book concludes with an extensive and very interesting list of statistics of results of the author's 446 cases.

Westminster Hospital Reports. Edited by STANFORD CADE and DONALD PATERSON. Vol. XX, 1924-1928. Demy 8vo. Pp. 343 + viii, illustrated. 1929. (Published October.) London : H. K. Lewis & Co. Ltd. 7s. 6d. net.

THE lively interest in the problems of radium therapy which is being shown by the staff of the Westminster Hospital is common knowledge ; but the publication of the Hospital *Reports* for 1924-1928 testifies to the efficiency of the work done in the wider fields of medicine and surgery. In addition to the usual statistical tables, the volume contains ten original articles, only one of which deals with radium, and this is in the nature of a statistical inquiry.

Sir James Purves-Stewart gives an account of his method of pneumo-radiography in the diagnosis of cerebral tumours, with case histories and clear reproductions of skiagrams to illustrate his argument. He does not dwell upon the dangers of the procedure or upon the relative merits of alternative methods of carrying out ventriculography. This is followed by an extremely valuable survey by Mr. Rock Carling of twenty-four patients treated by periarterial sympathectomy. He considers the operation to be of value in the treatment of Raynaud's disease, acrocyanosis, and intractable ulcers ; but the results were disappointing when endarteritis was present, or when pain was the only reason for operating.

Dr. Adolphe Abrahams contributes an interesting article on " Exercise and the Cardiac Rate " in which he shows that poor response to exercise in cases of 'effort syndrome' is to be related more to a general lack of co-ordination in the body as a whole than to any disease of the heart. In a paper on " Cataract " Mr. A. F. MacCallan makes a plea for the elimination of focal sepsis wherever it may be found in all cases of early lenticular opacity, since chronic focal sepsis is in his experience the only constant accompaniment of the changes in the eye leading to cataract formation, and to neglect the condition till it is well established means irreparable damage to the lens.

Dr. Allchin gives an account of six cases of lymphadenoma treated by X rays, and Dr. Dunlop describes some significant experimental work on the effect of ether anæsthesia on the action of adrenalin upon the circulation.

There are three papers dealing with uncommon diseases : " A Case of Mycosis Fungoides " by Dr. S. E. Dore and Dr. H. Thompson Barron ; " A Case of Cysti-cercus Cellulosæ of the Brain in a Human Subject " by Dr. Braxton Hicks ; and an exhaustive study of six cases of Werdnig-Hoffmann paralysis by Dr. Donald Paterson. The last paper is particularly important, and is illustrated by a series of excellent drawings and photographs of patients and microscopical preparations. The author inclines to the view that Werdn.· II ·····, · ....: ·. · .· : Oppenheim's disease have the same pathological basis ; a · ·· : ·· · · ·· · · ·· ..: ·· is appended.

The radium article by Mr. Rock Carling and Mr. Stanford Cade gives in tabular form an account of the clinical condition, method of application of radium, and the result of treatment in 190 patients. To all those who are working at the surgical applications of radium this contribution will be of much value ; and only those who have attempted to follow up and criticize their own work will appreciate the labour which the compilation of this table must have entailed, and the high standard achieved by its authors.

The latter half of the volume consists of an abstract of the post-mortem examinations carried out from 1924 to 1928, a catalogue of specimens added to the Museum during that period, and the report of the Pathologists and Registrars. Though all these returns contain much that is of interest, no special comment is called for. It may fairly be stated that Volume XX of the *Reports* is a production upon which the editors and the staff of the Westminster Hospital are to be congratulated.

Collected Papers of the Mayo Clinic and the Mayo Foundation. Edited by Mrs. M. H. MELLISH, RICHARD M. HEWITT, M.A., M.D., and MILDRED A. FELKER, B.S. Vol. XX, 1928. (Published June, 1929.) Medium 8vo. Pp. 1197 + xx, with 288 illustrations. 1929. London and Philadelphia : W. B. Saunders Co. 60s. net.

IN the compilation of the twentieth volume of this series, 429 papers were considered, Of these " eighty-one are reprinted, forty-three are abridged, seventy-two are abstracted, and of 233 references only are given." This shows that a lapse of twenty years has seen a great change in the character of the volume, which at first contained all the publications of the Clinic. It is obviously wasteful in every sense to reprint a paper the value of which is limited owing either to the scope of its subject or the narrowness of its appeal. In fairness to the literary activity of the Clinic, it must be recognized that this volume in no way represents the total of their output.

Drs. Walter C. Alvarez and W. C. MacCarty, from a study of the size of over 600 resected gastric ulcers, reaffirm MacCarty's statement that any chronic gastric ulcer with a crater more than one inch in diameter is probably cancerous, but if smaller than this, the chances are ten to one that it is benign. Kirklin's paper on the X-ray recognition of duodenitis draws timely attention to a condition which is usually mistaken for, and treated as, actual duodenal ulceration. The same author contributes a moderate and very well-balanced appraisal of cholecystography. He concludes that it possesses a diagnostic excellence at least equal to that of accepted tests for other diseases. The enormous experience of surgeons in the Clinic is shown by Waltman Walters' paper on strictures of the bile-ducts : of 17 operations for benign stricture, no fewer than 13 followed cholecystectomy.

From the large number of contributions relating to surgery of the colon, it is evident that several members of the Clinic are interested in this branch of surgery. F. W. Rankin contributes an account of a considerable piece of work in which he endeavours to carry out an aseptic method of intestinal anastomosis. From the written and pictorial description of his procedure it is difficult to make certain that one grasps every detail. It is clear that the risk of contamination of the peritoneum from the divided ends of the bowel is, if not absolutely excluded, certainly reduced to a minimum ; but in every case of actual anastomosis a suture is employed, and one cannot help wondering whether the author has overlooked the fact that, as Halsted showed, it is impossible to introduce this suture without encroaching upon layers of the intestinal wall, from which infection may proceed.

The surgery of the sympathetic system is still in its infancy. The paper by Judd and Adson on lumbar sympathetic ganglionectomy and ramisectomy for congenital idiopathic dilatation of the colon shows how successful this treatment was in two cases   The description of the technique is lucid, and is much assisted by a most beautiful drawing by R. Drake. Diseases of the thyroid occupy a smaller proportion of this volume than in some of the former numbers, but a comprehensive review of the present state of our knowledge of the pathology of thyroid diseases is afforded by Walter M. Boothby's paper read before the Medical Society of Sweden on the thyroid problem. The credit of the application of phrenicotomy in the treatment of diaphragmatic hernia must be given to Stuart W. Harrington. It is used either as a palliative procedure or as a preliminary to radical treatment. The article is exceptionally well illustrated.

In the preceding remarks attention has been drawn to a few of the papers which appear to the reviewer to be of outstanding merit, of general surgical interest, or which are, probably, upon subjects in which he himself is interested. There are, of course, many other articles, of which any one interested in a special line of surgery must have cognizance. Some of the most important contributions of the year are only referred to in abstract. It will not be questioned that while one surgeon who is interested in one branch will read one set of papers, and another will make a different selection, all who open this volume will be attracted to the writings of Drs. W. J. and C. H. Mayo on general subjects, particularly to the former's paper on " The Advancement of Learning in Medicine through Biochemistry." It is full of evidence of wide scientific knowledge, and it is no mean feat of this author to have been able to interest the American Chemical Society in the application of chemistry to modern medicine. But the plum of the whole volume is Dr. Louis B. Wilson's biography of William Worrall Mayo. As a statement of unadorned fact it is a model of what such a paper should be. Admittedly, Dr. Wilson had as his subject a most fascinating personality—a pioneer in a new country with a highly scientific mind. Every reader who retains a fragment of the spirit of boyhood must be fascinated by Dr. Mayo's adventures, and filled with admiration for his personality. One doubts whether medical history can afford a parallel in which so great a father has produced two such eminent sons.

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St. Bartholomew's Hospital Reports. Edited by Sir THOMAS HORDER, Bart., K.C.V.O., RONALD G. CANTI, WILFRED SHAW, W. LANGDON BROWN, W. GIRLING BALL, and GEOFFREY EVANS. Vol. LXII. Demy 8vo. Pp. 262 + xxv, illustrated. 1929. London : John Murray. 21s. net.

A LARGE portion of this volume is occupied by very ample papers on the dietetic treatment of various medical disorders. Several of these, such as that dealing with diabetic coma, should be helpful to surgeons treating the surgical complications of such a disease. Professor Gask contributes a paper on diverticula of the duodenum, which he concludes have little clinical significance. Sir Charles Gordon-Watson discusses the treatment of cancer of the rectum by radium from all possible aspects ; one gathers that at present he does not make use of it in preference to accepted operative measures. Sir Frederick Andrewes reviews recent work on hæmolytic streptococci, and though most of this concerns strains from scarlet fever cases, he points out that other streptococci, such as that of erysipelas, present close analogies.

Drs. Maxwell and Nicholson write on the incidence of primary malignant intra-thoracic new growths, and from an analysis of post-mortem records for the past sixty years argue that it has increased considerably since the War, though they are unable to assign any cause for this.

Devils, Drugs, and Doctors. The Story of the Science of Healing from Medicine-Man to Doctor. By HOWARD W. HAGGARD, M.D., Associate Professor of Applied Physiology, Yale University. Medium 8vo. Pp. 405 + xxii, illustrated. 1929. London : William Heinemann Medical Books Ltd. 21s. net.

IN spite of its catchpenny title, which after all is only a reversal of that given to one of his pamphlets by John Alexander Dowie, the faith healer, this book is well worth reading. Dr. Haggard is the Associate Professor of Applied Physiology at Yale University, and he writes therefore with a sound knowledge of his subject and a corresponding sense of responsibility. The work is intended primarily for the general public, though it may be studied with pleasure and profit by a medical man. It is based mainly upon the work of Ambrose Parey, who is clearly a hero to Dr. Haggard. The first section deals with " The Conquest of Death at Birth ". It treats of various birth customs and shows the advance made by Parey when he recommended podalic version. The work of Oliver Wendell Holmes and of Semmelweis in reducing the mortality of childbed, and that of Sir James Y. Simpson in lessening its pain, are adequately described, and the author then passes on to the progress of surgery. He tells how anatomy was taught, and in doing so makes the curious mistake of confusing the ordinary manuscript contraction for *orum* for the ℞ which heads a Latin prescription to this day. It is rather difficult to decide in the chapter " The Greatest Surgeon " whether Dr. Haggard considers Parey or Lister is to be preferred to that honourable position. Plague, pestilence, and famine are duly considered, and there is some very plain but necessary speaking about prostitution and syphilis on the broad lines of common sense. Finally, faith healers, chiropractics, *et id genus omne* are considered, and Dr. Haggard thinks that they would be less flourishing if the medical profession adopted a more sympathetic attitude towards minor and imaginary ailments. There are a few small mistakes which might be corrected in future editions—for instance, Lister does not lie in Westminster Abbey (p. 170), although a stately burial service was held there. Thomas Gale (p. 134) should not be Thomas Gales. John Ward was Vicar of Stratford-on-Avon after the Restoration, which was in the seventeenth, not the fifteenth century (p. 188). Philippe Record should of course be Ricord (p. 252). Bayle is wrongly indexed in two places, but in each Robert Boyle is probably meant.

The illustrations add much to the book, and there are some pretty initial blocks for the capital letters showing scenes from a dance of death.

Les Accidents de la Cholecystectomie. By SERGE HUARD, Ancien Interne des Hôpitaux de Paris. Preface by Dr. ANSELME SCHWARTZ, Professeur agrégé à la Faculté de Médecine de Paris. Medium 8vo. Pp. 116 with 17 illustrations. 1929. Paris : Masson et Cie. Fr. 16.

THIS is a very interesting little book which deals aptly with the various accidents that may attend the operation for removal of the gall-bladder. The normal and abnormal anatomy of " la région des voies biliaires " is carefully described and illustrated, much care being devoted to the anomalies of the vessels. An interesting section deals with pathological anomalies, and there are some good diagrams. Having shown that anomalies of one kind and another are fairly common, Huard contends that the success of the usual methods of removing the viscus depends more on the watchful care of the operator than the suitability of the technique. A new technique is described which the author associates with the name of Professor Schwartz and himself. The main feature appears to be the separation of the gall-bladder from the liver in the middle of its attachment, the structures in the gastro-hepatic omentum being then pushed downwards and inwards so that the cystic duct is exposed from above. There is nothing in the description or in the diagrams

which accompany it to suggest that any less care is necessary with this than with the other and more familiar methods. There is a brief summary of no fewer than seventy reported cases of the various injuries that have followed cholecystectomy. Several cases from the British literature are not included, and similar omissions mark the otherwise comprehensive bibliography.

Radium and Cancer (Curietherapy). By DUNCAN C. L. FITZWILLIAMS, C.M.G., M.D., Ch.M., F.R.C.S., Senior Surgeon and Lecturer in Clinical Surgery, St. Mary's Hospital, etc. Demy 8vo. Pp. 172 + vii, with 80 plates (4 coloured) and 64 illustrations in the text. 1930. London : H. K. Lewis & Co. Ltd.   12s. 6d. net.

IN the present state of radium therapy in Great Britain any record of the methods adopted by a surgeon who has considerable experience must be valuable. This book is such a record, and claims to be a guide only " to those whose supply of radium is . . . limited ". Its general plan follows closely that of a somewhat earlier and already well-known book. The author does not attempt to disguise the very elementary—'elemental', he says—state of our knowledge of the problems involved ; he speaks with proper hesitancy as to dosage, choice of method, and spacing of treatment, even if here and there he seems surer that others are wrong than that he himself is right. " Successes ", he says in the introduction, " are what we expect ", and no doubt that is the correct attitude to adopt when trying out any new attack on cancer. The published percentage of cures from the best sources about the most favourable types of cases are, however, so modest that cool expectations cannot be very high.

The chief defect of the book—excusable, of course—is that there seems to be no attempt at helping the tyro to visualize the fields around individual needles or groups of needles interstitially implanted, or delivered from plaques of surface application. Probably if the field were plotted from such an arrangement as the gridiron figured beneath the breast on page 79 it would lead the author to modify that particular technique. It is notoriously difficult so to implant needles as to secure a uniform irradiation of the full extent of a growth, and it is a pity in any way to minimize this point, for not everyone can attain the adroitness of the author, especially when implanting through such a tube as the sigmoidoscope, or approaching the tonsil from without.

The sections on oral cancer disclose nothing new in method or results. Metastases in cervical glands are dealt with by block dissection in all cases, with insertion of needles at the end of the operation. Diathermy, the author considers, should not be employed, as " infection of the glands must be more common after such a proceeding ". The author's views on the operative treatment of cancer of the breast are unorthodox. He carries his views, logically, into the use of radium. It is unnecessary to put needles above the clavicle or in the intercostal spaces, but on the other hand they should be " thrust into the chest at the anterior ends of the intercostal spaces . . . where the glands are situated ". This procedure seems not without danger. On the whole, the favourable view which is taken of the prospects of cure of cancer of the breast will, it is to be feared, raise false hopes both in the sufferers and surgeons.

The chapter on the rectum is tentative and it is not always clear exactly what the author intends by his directions. He is not afraid to use radium in a tube in the lumen at the same time that his interstitial needles are in position, nor to open the peritoneum when implanting from below without a preliminary colostomy. The sections dealing with the œsophagus and stomach reflect the present state of uncertainty and experiment everywhere prevailing. In speaking of cancer of the prostate it is stated that in early cases micturition soon becomes normal again as " the result of almost any kind of radium treatment ". This experience is happier than that of many other surgeons, who, it must be confessed, are not lucky enough often to meet with 'early' cases, except where the prostate already has been removed. Cancer of the bladder and penis is treated on usual lines : cancer of the larynx after the style of Harmer. In speaking of cancer of the thyroid it is stated that the trachea and laryngeal cartilages " may be protected with lead rubber tissues ",

but the method is not explained. With parotid tumours the author seems to have had success, reducing the growth to a cyst containing thick blood-stained fluid that can be easily evacuated. The chapter on the uterus and vulva is by Malcolm Donaldson and is everything that is to be expected from his great experience and facile pen.

The book is well illustrated, and the case records give an idea of the success Mr. Fitzwilliams has had in many fields with the use of radium. In another edition the author might, with a little trouble, make his meaning clearer and his directions more precise in a good many places. His proof-reader will no doubt correct 'glands' to 'glans' (p. 138 twice), and 'sewn' to 'sown' (p. 130).

Chirurgie des Os et des Articulations des Membres. By P. LECÈNE, Professeur à la Faculté de Médecine de Paris ; Chirurgien de l'Hôpital Saint Louis. With the collaboration of P. HUET, Chirurgien des Hôpitaux de Paris. Pp. 591, illustrated. 1929. Paris : Masson et Cie. Paper covers, Fr. 125 ; bound, Fr. 140.

THIS volume sets out to give a full account of the present practice of this branch of surgery for students who intend to become surgeons. It is practically entirely devoted to operative methods, and describes these procedures as they are practised in France at the present day, giving a concise and well illustrated account of them. A large part of the book is devoted to the older and more classical methods, most of the more recent ones being dealt with by reference only unless they are those of French surgeons, so that, for example, the modern methods of bone-grafting with a mechanical saw, and Putti's methods of arthroplasty, are left undescribed.

The work will be chiefly useful for reference on a few particular methods that have been elaborated by French surgeons.

Minor Surgery. By FREDERICK CHRISTOPHER, M.D., F.A.C.S., Associate in Surgery at Northwestern University Medical School. With a Foreword by ALLEN B. KANAVEL, M.D., F.A.C.S., Professor of Surgery, Northwestern University Medical School. Medium 8vo. Pp. 694, illustrated. 1929. London and Philadelphia : W. B. Saunders Co. 36s. net.

THIS volume is a comprehensive survey of the subject, and covers a field which is important to nearly every practitioner and yet one which is often crowded out of the ordinary course of surgical teaching. The planning of the book on an anatomical basis, with a description of minor ailments as they affect each different part, has tended to redundancy and an unnecessary increase in bulk. As an example, the excellent chapter on furuncles and carbuncles near the beginning of the book renders unnecessary any further description of these conditions in various regions.

Although the limits of 'minor' surgery are indefinable, there are a few surprising omissions and inclusions. In the chapter on the anus and rectum there is no mention of the injection treatment of internal hæmorrhoids, while the 'major' operations of ligature and excision and clamp and cautery are described in detail. Similarly, a careful description of the operation for varicocele would seem to be beyond the scope of this book, while the condition of spermatocele is not mentioned, and the use of trusses in the treatment of hernia is a subject which merits more extensive discussion than it is given in the section on deformities of the trunk.

The chapters on injuries and infections of the upper extremities are excellent. We welcome the description of methods other than Sayre's for treating a fractured clavicle. An account of the technique of using plaster bandages is also an excellent inclusion, and seldom found in any general text-book. The corresponding chapters on the lower extremities are not so good, such conditions as congenital dislocation, pseudocoxalgia, and tuberculous disease being omitted from the discussions on affections of the hip-joint.

The chapter on minor surgical technique and similar descriptions throughout the book are very good, although a section on suture materials would be a welcome addition. The chapter on the 'surgical intern' contains much that is of great value about post-operative care and the complications which may arise during

this period. The remarks about the personal qualities and obligations of an 'intern', although perhaps not appealing to the average British house surgeon, recall strongly the description by John Arderne of the " Qualities required in a Good Surgeon ", written six centuries ago.

The printing is good and only a few minor misprints were noted. There are numerous illustrations and photographs, all of which are extremely clear and helpful.

Die Chirurgie. A System of Surgery. Edited by Professors M. KIRSCHNER (Tübingen) and O. NORDMANN (Berlin). Fasc. 25 (Vol. III). Royal 8vo. Pp. 387–608, with 105 illustrations in the text and 8 coloured plates. 1929. Berlin and Vienna : Urban & Schwarzenberg. RM. 15.

THE present number forms part of the third volume of the system, and it deals with the surgery of the brain with its coverings (Professor Egon Ranzi, of Innsbruck) and that of the vegetative nervous system (Professors Brüning and Stahl, of Berlin).

The discussion and description of the chief phases of cerebral symptoms are comparatively brief. Commotio cerebri or concussion is regarded as being due to sudden pressure upon the medullary and basal nuclei, rather than as a diffuse anæmia of the brain as a whole. The sections on gunshot wounds of the brain are more full and detailed than is usual and are illustrated with good coloured figures. In the description of thrombosis of the cavernous sinus, two methods of direct attack upon the seat of disease are mentioned, but the practical value of ligation of the angular vein is omitted. The section on tumours of the brain is very well illustrated, but otherwise it does not call for any special comment. In dealing with the technique of craniotomy, the use of a tourniquet round the head is given prominent mention ; local anæsthesia is recommended ; and the opening of the skull is to be by wide osteoplastic flaps, cut by motor-driven burrs.

The chapters on the sympathetic nervous system give an excellent summary of this very modern surgical problem. The anatomical drawings are both accurate and beautiful. The histological figures of the stellate ganglion would be of more value if the normal structure were depicted and the points of variation noted.

An Introduction to the Study of the Nervous System. By E. E. HEWER, D.Sc. (Lond.), Lecturer in Histology and Assistant Lecturer in Physiology at the London (Royal Free Hospital) School of Medicine for Women ; and B. S. SANDES, Demonstrator in Anatomy at the above School, Surgical Registrar to the London Lock Hospital for Women and Children. Crown 4to. Pp. 104 + xii, illustrated. 1929. London : William Heinemann (Medical Books Ltd.). 21s. net.

PRIMARILY written for students, this book gives, partly in tabular. partly in diagrammatic form, a general survey of the nervous system. This arrangement makes it a useful book of reference for many occasions : for those preparing for the higher examinations in medicine, anatomy, or physiology, and for those who have not the time to look up the many important individual papers to which reference is made in the text.

To the surgeon the most useful section at the moment is that which deals with the autonomic nervous system. At a time when experimental operations upon the sympathetic nerves and ganglia are being somewhat largely practised, surgeons would do well to remind themselves of the extreme complexity of that part of the nervous system into which tentative and not always wise plunges are from time to time made. They will then be prepared for the disappointments which await them.

The book is admirably produced, and the numerous coloured diagrams set forth very clearly the points which they are designed to illustrate.

BOOK NOTICES.

[The Editorial Committee acknowledge with thanks the receipt of the following volumes. A selection will be made from these for review, precedence being given to new books and to those having the greatest interest for our readers.]

The Cancer Process. By J. J. M. SHAW, M.A., M.D., F.R.C.S.E. Medium 8vo. Pp. 16. 1930. Edinburgh : E. & S. Livingstone. 1s. net.

Surgery of the Lung and Pleura. By H. MORRISTON DAVIES, M.A.. M.D., M.Ch. (Cantab.), F.R.C.S., Medical Superintendent Vale of Clwyd Sanatorium ; Consulting Surgeon to University College Hospital, etc. Demy 8vo. Pp. 355 + xvi, illustrated. Being one of a Monograph series entitled Regional Surgery. General editor, A. P. BERTWISTLE, M.B., Ch.B. (Leeds), F.R.C.S.E. 1930. London : Oxford University Press. 25s. net.

Die Chirurgie der Brustorgane. By FERDINAND SAUERBRUCH. Third edition. Vol. I. Die Erkrankungen der Lungen. Under the direction of H. ALEXANDER, H. CHAOUL, and W. FELIX. Part 2. Die chirurgische Behandlung der I   D\.
parasitären Erkrankungen der Lungen. Lungentumoren. Di   R
des Asthma bronchiale. Syphilis der Lungen. Imperial 8v   P .   ;
189 illustrations. 1930. Berlin : Julius Springer. RM. 98.

Demonstrations of Physical Signs in Clinical Surgery. By HAMILTON BAILEY, F.R.C.S., Surgeon, Dudley Road Hospital,   edition, revised and enlarged. Medium 8vo. Pp. 268 + xviii,   some of which are in colour. 1930. Bristol : John Wright & Sons Ltd. 21s. net.

A Shorter Surgery. A Practical Manual for Senior Students. By R. J. McNEILL LOVE, M.B., M.S. (Lond.), F.R.C.S., Assistant Surgeon, Metropolitan Hospital ; Hunterian Professor R.C.S. Second edition. Demy 8vo. Pp. 371 + viii, with 74 illustrations, including 31 plates (one coloured). 1930. London : H. K. Lewis & Co. Ltd. 16s. net.

Book of Diets. Bulletin McGuire Clinic St. Luke's Hospital. Second edition, revised. Royal 8vo. Pp. 48. Published quarterly by the staff, 1000 W. Grace Street, Richmond, Va.

Clinique et Thérapeutique chirurgicales. By GEORGE PASCALIS. Pratique Journalière. Medium 8vo. Pp. 290, with 80 illustrations. 1930. Paris : Gaston Doin et Cie. Fr. 50.

La Pratique chirurgicale illustrée. By VICTOR PAUCHET. Fasc. XV. Royal 8vo. Pp. 245, with 200 illustrations by S. Dupret. 1930. Paris : Gaston Doin et Cie. Fr. 65.

Orthopädie im Kindesalter. By Hofrat Prof. Dr. HANS SPITZY (Vienna), with the collaboration of Geh. Hofrat Prof. Dr. FRITZ LANGE (Munich). Third edition, fully revised and enlarged. Crown 4to. Pp. 504 + vi, with 253 illustrations. 1930. Leipzig : F. C. W. Vogel. Paper covers, M. 45 ; bound, M. 50.

Die Chirurgie. A System of Surgery. Edited by Profs. M. KIRSCHNER (Tübingen) and O. NORDMANN (Berlin). Fasc. 26 (Vol. II). Royal 8vo. Pp. 1583–1828, with 175 illustrations in the text and one coloured chart. 1930. Berlin and Vienna : Urban and Schwarzenberg. RM. 18.

Das Für und Wider der chirurgischen Behandlung des Gallenleidens, auf Grund der Erfahrungen an 800 Gallenoperationen. By Prof. PAUL ZANDER, Chirurg des Elizabethenstifts in Darmstadt. Royal 8vo. Pp. 89, with 8 illustrations. 1930. Leipzig : Georg Thieme. M. 8.50.

The Dramatic in Surgery. By GORDON GORDON-TAYLOR, O.B.E., M.A., F.R.C.S. Surgeon to the Middlesex Hospital. Medium 8vo. Pp. 88. Illustrated. 1930. Bristol : John Wright & Sons Ltd. 12s. 6d. net.

A Textbook on Orthopedic Surgery. By WILLIS C. CAMPBELL, M.D., F.A.C.S., Professor of Orthopedic Surgery, University of Tennessee College of Medicine, etc. Medium 8vo. Pp. 705, with 504 illustrations. 1930. Philadelphia and London : W. B. Saunders Co. 37s 6d. net.

Surgical Diagnosis. By American authors. Edited by EVARTS AMBROSE GRAHAM, A.B., M.D., Bixby Professor of Surgery, School of Medicine, Washington University, St. Louis, etc. 9¼" × 6". Vols. I and II. Vol. I. Pp. 919, with 508 illustrations. Vol. II. Pp. 871, with 326 illustrations. To be issued in three volumes and desk index volume. 1930. London and Philadelphia : W. B. Saunders Co. Per set £7 10s. net.

Research and Medical Progress and other Addresses. By J. SHELTON HORSLEY, M.D., Attending Surgeon, St. Elizabeth's Hospital, Richmond, Va. Crown 8vo. Pp. 208, illustrated. 1929. London : Henry Kimpton. 8s. 6d. net.

Diabetic Surgery. By LELAND S. McMITTRICK, M.D., F.A.C.S., Visiting Surgeon, Palmer Memorial Hospital ; and HOWARD F. ROOT, M.D., Assistant Physician, New England Deaconess Hospital. 9½" × 6". Pp. 269 + ix, with 79 illustrations in the text and 2 plates. 1929. London : Baillière, Tindall & Cox. 21s. net.

Radium in General Practice. By A. JAMES LARKIN, B.Sc., M.D., D.N.B., Radium Consultant on Staffs of Wesley Memorial, German Evangelical Deaconess, John B. Murphy, Washington Park Community Hospitals, Chicago, etc. Medium 8vo. Pp. 304 + xiii, with 28 illustrations. 1929. New York : Paul B. Hoeber Inc. $6.00

La Rachianesthésie: sa Valeur et sa Place actuelle dans la Pratique. By EMILE FORGUE, Professeur de Clinique chirurgicale à la Faculté de Montpellier ; and ANTOINE BASSET, Professeur agrégé à la Faculté de Médecine de Paris, Chirurgien des Hôpitaux. Medium 8vo. Pp. 222, with 23 illustrations. 1930. Paris : Masson et Cie. Fr. 30.

Guy's Hospital Reports. Edited by ARTHUR F. HURST, M.D. January, 1930. Vol. LXXX (Vol. X, Fourth Series). No. 1. Medium 8vo. Pp. 126, illustrated. 1930. London : Lancet Ltd. Annual subscription, £2 2s. net, or 12s. 6d. net per issue.

INDEX TO VOLUME XVII.

ATLAS OF
PATHOLOGICAL ANATOMY

FASCICULUS V.
DISEASES OF THE GALL-BLADDER AND
BILE-DUCTS. INFLAMMATION OF BONE.

Complied E. K. MARTIN, M.S., F.R.C.S.

CONTENTS

CARCINOMA OF KIDNEY. CALCULUS.

A left kidney divided by longitudinal section.

Practically the whole of the kidney has been replaced by a pale yellow, firm growth. The only remnant of kidney substance is seen as a thin sheet at the lower pole enveloping the lower half of a pigmented calculus, which extends into and fills the distorted renal pelvis. A smaller calculus the size of a hazel-nut is seen in one of the upper calices.

The larger calculus measures 3·5 × 7 cm. and weighs 80 grm. On section, it is laminated, and is composed of alternating layers of chalky white phosphates and pigment.

Museum of the College of Medicine, University of Durham, Newcastle-upon-Tyne, C.1857

MICROSCOPIC STRUCTURE.—Squamous-cell carcinoma.

CLINICAL HISTORY.—The patient was a man, aged 56, who had had abdominal pain, particularly at night, for six weeks. During this time he lost one stone in weight. On examination, he was tender in the left flank, where an indefinite tumour could be felt.

X-ray examination showed a shadow in the left kidney, and this was confirmed by pyelography. The kidney was removed by the lumbar route.

No after-history.
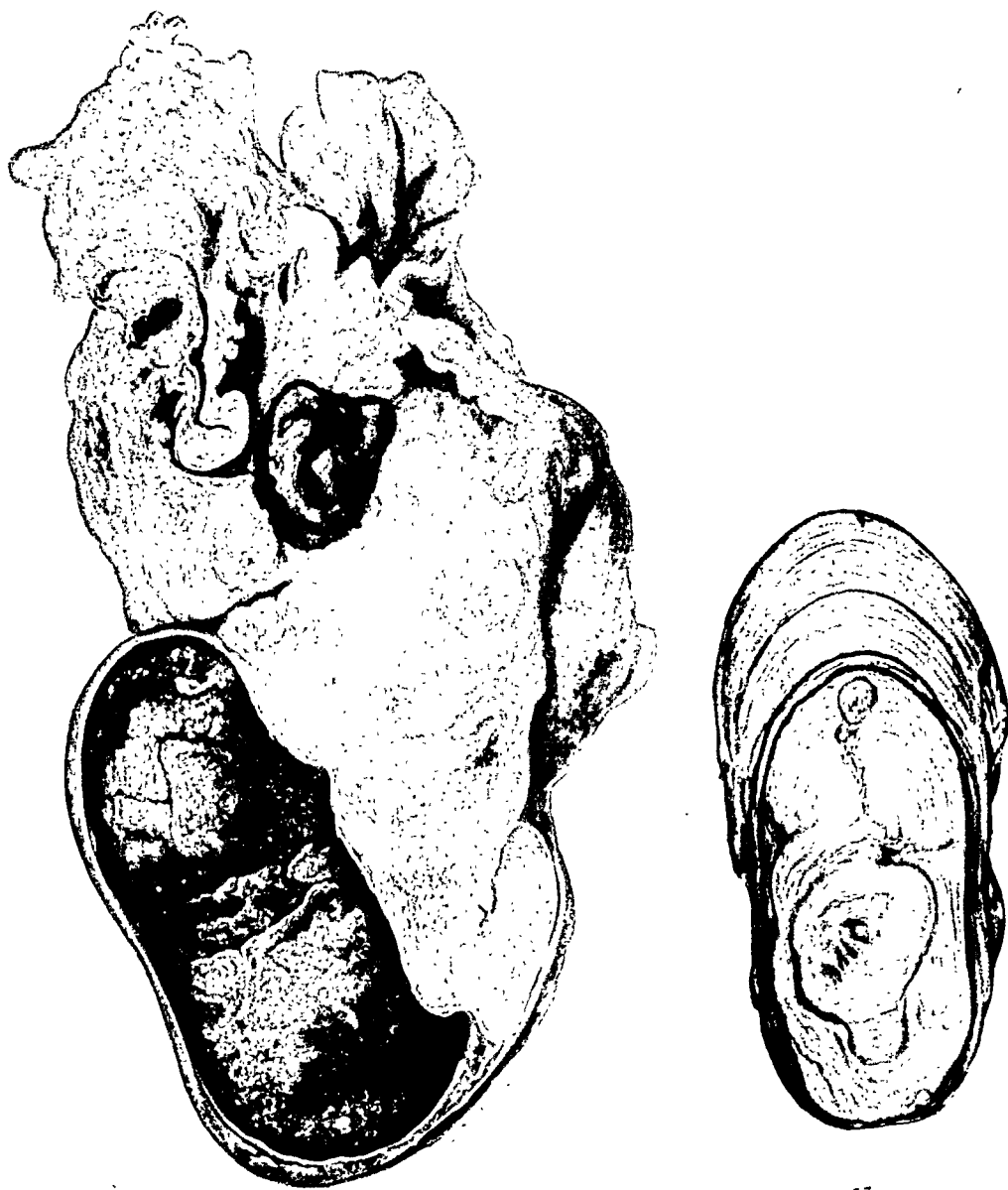
394

CARCINOMA OF ADRENAL.

The right adrenal gland and kidney, removed after death and divided by longitudinal section.

The adrenal is enlarged so as to exceed the bulk of the kidney by a vascular tumour arising from the cortex.

Hunterian Museum, R.C.S. 1736.1

MICROSCOPIC STRUCTURE.—The tumour consists of a close plexus of capillaries, in the meshes of which lie groups of polyhedral cells in close apposition to one another. Here and there are spaces lined by cylindrical epithelium. The cytoplasm of the cells is clear and vacuolated, as in adrenal neoplasms.

CLINICAL HISTORY.—The patient was a medical man, aged 45, who felt a sudden pain in the right elbow whilst dancing. A year later a swelling appeared, which was proved by skiagraphy to be a central tumour of the humerus. The lower end of the bone was excised and is illustrated as specimen No. 2088.1 (page 397).

A local recurrence took place, and this was treated by a second excision. By means of an elastic bandage the forearm could be fixed to the arm with such efficiency that the patient could write, and continue his practice, even being able to apply midwifery forceps. Death occurred suddenly five years and four months later.

AUTOPSY.—Both adrenals were enlarged by plum-coloured tumours. The abdominal lymph glands were similarly diseased so as to resemble dull-red grapes. There was a metastatic nodule in the interventricular septum, projecting among the chordæ tendineæ of the mitral valve. The microscopic structure of this was of the adrenal type. There was no further recurrence in the right upper limb (R.C.S. No. 436.1).

Atlas of Pathological Anatomy
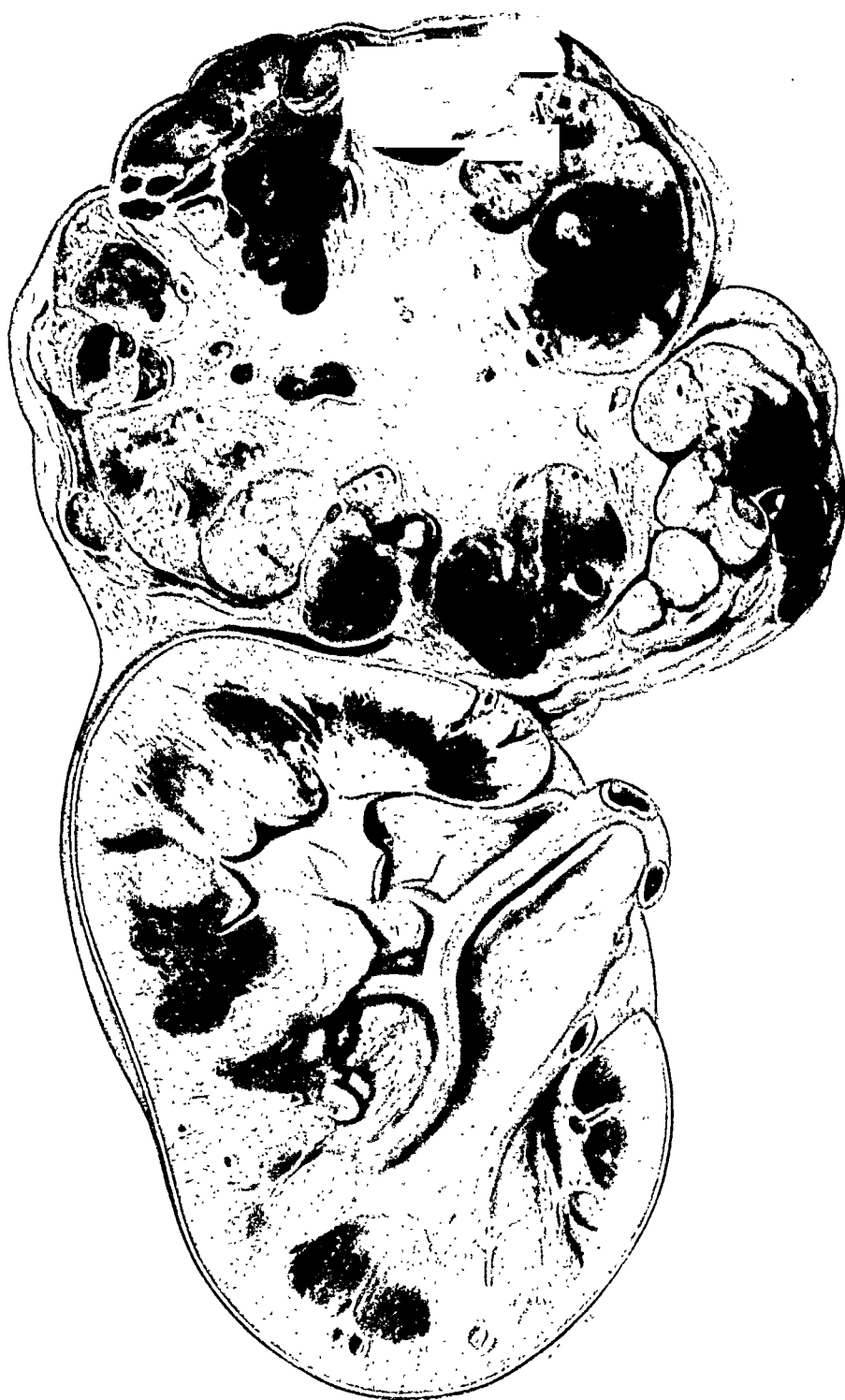
CARCINOMA OF ADRENAL.

(SECONDARY DEPOSIT IN BONE.)

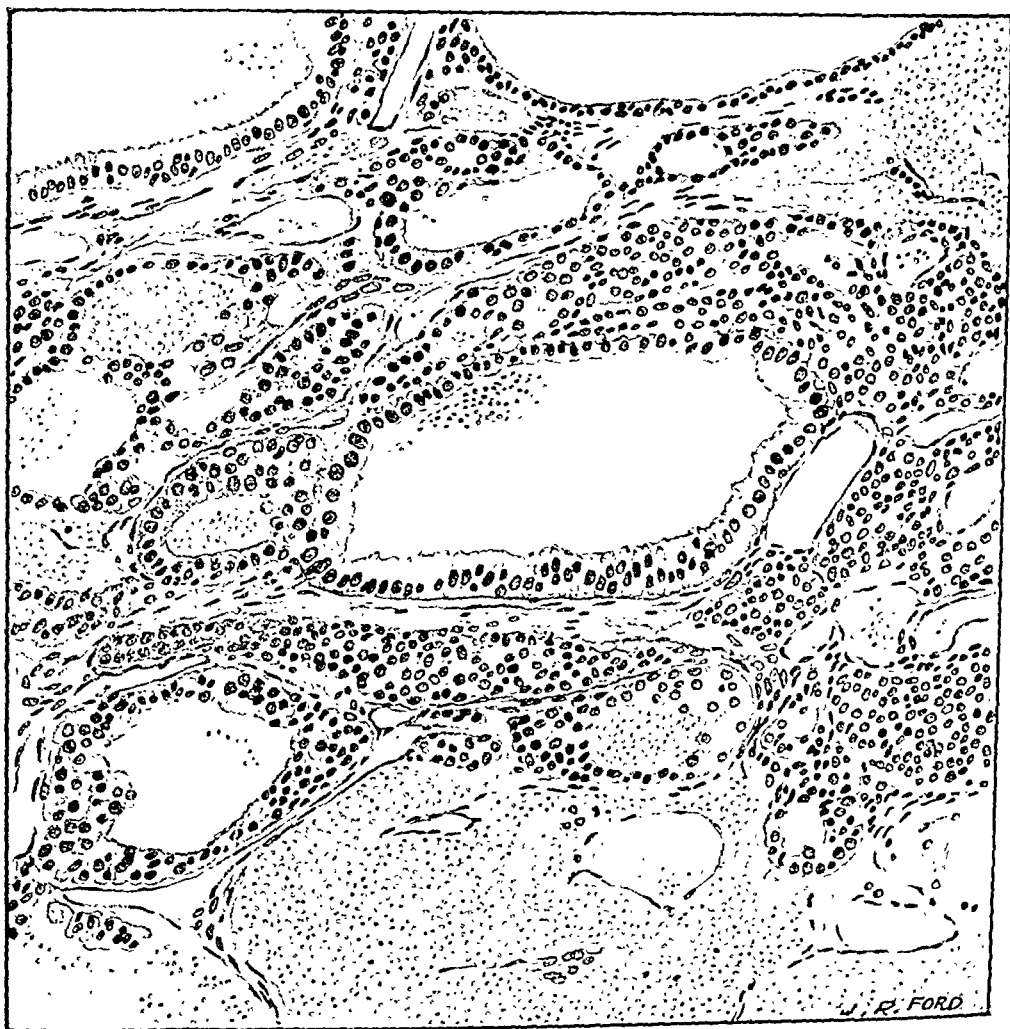The lower four inches of a right humerus divided by longitudinal section.

The shaft is widely expanded by the growth of a very vascular central tumour.

Hunterian Museum, R.C.S. 2088.1

From the same case as Specimen No. 1736.1 (page 396).

NO. 17—SUPPLEMENT   R 1

/ 220

XIX. THE GALL-BLADDER AND BILE-DUCTS.

MALFORMATIONS.

EVERY possible variation of stenosis or absence of the biliary passages has been recorded. Congenital stenosis or obliteration of the ducts is usually associated with cirrhosis of the liver, and is probably due to intra-uterine inflammation. The subjects seldom survive for more than a few weeks.

The rare diverticulum of the common bile-duct is of greater interest. It appears clinically in female children as a cystic swelling below the liver, and causes jaundice by pressure on the common bile-duct.

INJURY.

The gall-bladder, like other hollow viscera, may be ruptured by forcible compression of the abdomen. Volvulus of the gall-bladder is dependent on the presence of a mesentery or on the absence of any attachment to the rest of the biliary apparatus other than that afforded by the cystic duct. The gall-bladder may be strangulated by a band. All these conditions are rare.

INFLAMMATION.

When the biliary passages are infected they are infected as a whole, and the micro-organisms concerned can usually be isolated from the bile. The chief brunt of the infection, however, falls upon the gall-bladder, because it is a blind diverticulum from the bile-duct with a narrow outlet. The gall-bladder is, therefore, the centre of surgical interest in inflammation of the biliary tract.

The micro-organisms which are the cause of cholecystitis probably reach the gall-bladder through the systemic blood-stream or through the lymphatics. Infection of the bile by bacteria which are carried to the liver by the portal vein can only occur if the liver cells have been damaged by toxins formed by the said bacteria. This commonly happens in typhoid and paratyphoid fever, but seldom produces cholecystitis. It is unlikely that the gall-bladder can become infected by the passage of bacteria up the bile-duct from the duodenum.

The micro-organisms commonly found in infected gall-bladders are those of the *B. coli* group and streptococci. The infection is frequently a mixed one. Inflammation is far more common in gall-bladders which contain stones than in those which contain bile alone. The pathological appearances of non-calculous cholecystitis do not present sufficient differences from those of calculous cholecystitis to warrant separate description. All degrees, from

catarrhal inflammation to gangrene, may occur. The changes which are produced in the gall-bladder as the result of inflammation will be described in connection with gall-stones.

GALL-STONES.

Gall-stones are very common. In England they are found in about 6 per cent of routine autopsies. They are usually formed in the gall-bladder, from which a negligible proportion may be passed by painful peristalsis through the cystic and common ducts into the duodenum, to leave the body by the bowel. They may be retained and grow larger in the common duct, and occasionally they are deposited in the lesser ducts within the liver. The disease is about four times as common in women as in men, and is most often seen in stout women of middle age who have borne children. This latter factor is associated with the great increase in the cholesterol content of the blood which accompanies pregnancy.

Chemical Constituents of Gall-stones.—The chief constituents of gall-stones are cholesterol, calcium salts, and bile pigments.

Cholesterol is a crystalline substance derived from the fat-containing foods and from the breaking-down of cells within the body. It is absorbed from the intestine and circulates in the blood, from which it is excreted by the liver into the bile. In the gall-bladder the bile is concentrated to a high degree, and this concentration may reach a point at which crystallization of the cholesterol occurs. In some cases the excess of cholesterol may be absorbed by the lining epithelium of the gall-bladder and deposited in the mucous membrane in the form of cholesterol esters. Such deposits may be shed into the lumen of the gall-bladder and form the nuclei of cholesterol stones which grow in the concentrated bile. It is doubtful if any cholesterol is secreted by the epithelium of the gall-bladder.

Varieties of Gall-stones.—

CHOLESTEROL STONE.—The cholesterol stone is usually single and of moderate size, round or oval in shape, and of a light buff colour. The surface is most often slightly nodular, but may be smooth. On section, the translucent crystals of which it is composed are seen radiating from a pigmented centre. This type of stone is composed of pure cholesterol, with traces only of calcium salts. Very rarely it may be multiple, when there are either two or three stones similar in appearance to the single cholesterol stone, or a very large number of small stones resembling seed pearls.

A gall-bladder which contains a pure cholesterol stone shows no evidence of previous inflammation, either on naked-eye or microscopic examination, and the bile which it contains is sterile on culture. It is supposed that the cholesterol stone is deposited by crystallization from bile with a high cholesterol content—i.e., that it is of metabolic origin, and that infection plays no part in its formation.

MULTIPLE, LAMINATED STONES.—These are composed of a mixture of cholesterol, calcium salts, and bile pigment, and constitute the common variety of gall-stone. They are multiple, faceted stones, varying in colour according to the proportion of bile pigment in their composition and the

degree of staining of their surface by bile. On section, they are seen to be made up of concentric layers of the cholesterol–chalk–pigment mixture.

The gall-bladder in which such stones are found shows unmistakable signs of past or present inflammation in all its coats, and a variety of bacteria can often be cultivated from the bile which it contains.

COMBINATION STONE.—In this variety the metabolic and inflammatory modes of formation have been combined. It is a large stone, composed of a central nucleus of pure cholesterol arranged in radiating crystals, surrounded by concentric layers of the cholesterol–chalk–pigment mixture which is characteristic of the common variety of gall-stone. The combination stone is often found impacted in the neck of the gall-bladder and accompanied by other smaller stones of the ordinary faceted type. Its origin is probably as follows. The crystalline cholesterol centre was formed under aseptic conditions from bile with a high cholesterol content, and became impacted in the neck of the gall-bladder. As a result of this obstruction, the gall-bladder became infected and the conditions necessary for the formation of the ordinary mixed calculi became established. Cholesterol–chalk–pigment mixture was then laid down on the surface of the original pure cholesterol stone.

PIGMENT STONE.—A pigment stone is black or dark brown in colour and has an irregular surface (mulberry calculus). It varies considerably in size, but is seldom more than a quarter of an inch in diameter. It may be single or multiple, and in the latter case is not faceted. Chemically it is a bilirubin-calcium compound. Pigment stones are usually hard, and may be brittle, but the substance of which they are composed may also be deposited in the gall-bladder or common bile-duct in a state of fine subdivision. A material resembling mud results, and this may adhere loosely to the surface of pre-existing stones.

Clinically, the pigment stone seldom causes symptoms, and little is known about the conditions of its formation, except that it is common in congenital hæmolytic jaundice.

FOREIGN BODIES.—Cases have been recorded in which a stone has formed round an unabsorbable ligature or suture remaining from a previous operation.

Effects produced by Gall-stones.—The effects produced by gall-stones are due either to inflammation or to obstruction of some part of the biliary tract, or to a combination of the two conditions. Besides these common effects, gall-stones are usually present in a gall-bladder which is the seat of carcinoma, and probably play some part in its development by acting as a source of chronic irritation. Pigment stones, and in some instances cholesterol stones, may be found at autopsy in gall-bladders which appear normal to naked-eye inspection.

INFLAMMATION.—

Acute Calculous Cholecystitis.—The gall-bladder is enlarged unless it has been rendered incapable of distension by chronic inflammatory fibrosis of its walls. Its peritoneal coat is bright-red and œdematous and may be flecked with lymph. On section, the wall is thickened by inflammatory exudate and the mucous membrane is injected and often ulcerated. The fluid contents in addition to the stones are mucus in excess and turbid bile or pus, mixed with blood in the hæmorrhagic forms of inflammation. Gangrene of the

gall-bladder may occur if its neck is blocked, but is rare in the absence of obstruction. A gangrenous patch may perforate.

Chronic Calculous Cholecystitis.—The gall-bladder is shrunken, thick-walled, and adherent to surrounding structures. It may be tightly contracted round its contained stones, or may contain bile, pus, or mucoid fluid in addition to them. The mucous membrane is often ulcerated round a stone impacted at the neck, and small stones may be found embedded within its substance. Contraction of the fibrous tissue in the base of an ulcer may lead to stenosis, either at the neck or in the middle of the gall-bladder. Calcification of the wall is very rare.

The 'strawberry gall-bladder' (lipoid gall-bladder) is a common form of mild chronic cholecystitis. It owes its name to a fancied resemblance of its mucous membrane to the fruit. From the outside the gall-bladder, which may, but does not necessarily, contain stones, presents little sign of disease other than the loss of its usual blue, translucent appearance. Within, the mucous membrane is studded with small red elevations the summits of which shine as bright yellow spots and streaks.

Microscopic examination shows the elevations to be the rugæ of the mucous membrane swollen by deposits of a doubly refracting lipoid which distends the endothelial cells of the lymphatic spaces. This lipoid is a choles-terol ester, and is the substance which reflects light from the elevations of the mucous membrane. The 'strawberry' appearance may be confined to one part of a gall-bladder or may involve the whole of its inner surface. In the latter case the cholesterol content of the gall-bladder is increased to many times its normal amount.

The significance of deposits of cholesterol ester in the wall of the gall-bladder may be considered in connection with the small calculi which are sometimes found embedded in its mucous membrane, as if they had been formed beneath the surface epithelium. The microscopic appearance of the 'strawberry' gall-bladder also suggests the possibility that a projecting portion of the mucous membrane, consisting of a mass of lipoid enclosed within a layer of epithelium, may become detached to form the nucleus of a gall-stone.

In rare cases a papillomatous hypertrophy of the mucous membrane results from the chronic irritation of a stone.

BILIARY FISTULA.—A fistula is sometimes formed as the result of ulcera-tion round an impacted gall-stone. The site of impaction is usually the neck of the gall-bladder, and the ulcer may perforate into a portion of the peritoneal cavity which has previously been shut off by inflammatory adhe-sions, or into a neighbouring viscus, such as the duodenum, stomach, or transverse colon. When perforation occurs into a localized portion of the peritoneal cavity, the resulting abscess may burst on the surface of the skin or into another viscus, the resulting fistulæ being termed external and internal respectively. The most common type of biliary fistula is that through which a stone escapes from the gall-bladder into the duodenum. The stone is generally a large one, and its successful elimination from the body depends upon whether it can pass the ileocæcal valve. If it cannot do so it causes acute intestinal obstruction by inducing a localized spasm in the lower part

of the small intestine. A stone impacted in the lower part of the common bile-duct above the ampulla may ulcerate through into the duodenum.

OBSTRUCTION.—It is only in the case of the gall-bladder that the mechanical effects of obstruction can be differentiated from the inflammatory effects. The presence of a stone in the common bile-duct always produces a combination of obstruction and inflammation.

Obstruction of the neck of the gall-bladder by a stone prevents the admission of bile through the cystic duct, and causes distension of the viscus by the secretion of a clear mucoid fluid from its walls. The distended gall-bladder is usually palpable and often visible through the abdominal wall on clinical examination (cystocele). The peritoneal coat is free from adhesion to surrounding viscera, the wall is thin, and the mucous membrane is normal except for the stretching. The stone is a pure cholesterol calculus—i.e., one which has been formed in the absence of infection. If the contents of an obstructed gall-bladder become infected and suppuration occurs, the resulting cholecystitis is severe and the influence of the obstruction is seen in a greater tendency to gangrene of the wall.

When a gall-bladder contains many stones one of which is impacted in its neck, the obstruction is often incomplete and infection is always present. The influence of the inflammatory factor in causing contraction then overshadows that of the obstructive factor which produces dilatation, and the gall-bladder remains thick-walled and shrunken.

EFFECTS OF STONES IN THE BILE-DUCTS.—When the common bile-duct is obstructed by a gall-stone the mechanical effects are always accompanied by inflammatory changes resulting from the coincident infection. The bile-ducts become distended with retained bile, while the gall-bladder, though it may be filled to capacity, remains contracted in consequence of the inflammatory changes in its walls. A stone impacted in the ampulla of Vater prevents the passage of bile into the duodenum and causes jaundice. The impaction is seldom maintained, because the common duct becomes distended above the obstruction to a diameter greater than that of the calculus, which is then able to slip back and allow the accumulated bile to escape past it into the bowel. Repetition of this phenomenon results in that alternation of obstruction and flow of bile which is the mechanical correlative of fluctuating jaundice.

The infection which accompanies the presence of a stone in the common duct causes an inflammatory thickening of its walls and of those of the hepatic ducts, while, if the obstruction be long continued, the smaller ducts within the liver become surrounded by round-celled infiltration and fibrosis. Adhesions may form between the surface of the liver and the diaphragm as the result of perihepatitis. The most acute types of cholangitis end in the formation of multiple abscesses of the liver.

Another consequence of the presence of a stone in the lower end of the common duct is infection of the pancreas and of its duct. Every degree of pancreatitis may occur, from the acute hæmorrhagic form to a localized chronic induration of the head of the gland. In rare cases stones may form in the pancreatic duct.

TUMOURS OF THE GALL-BLADDER AND BILE-DUCTS.

Simple tumours are rare, the most common being *papilloma*, which occurs in the gall-bladder in association with stone.

Carcinoma of the gall-bladder is a relatively common disease, and is almost always associated with gall-stones. Hence it is much more common in women than in men. Both infiltrating and fungating types occur. The infiltrating scirrhus variety of carcinoma commences as a local tumour, usually at the fundus, and tends to spread along the walls of the gall-bladder until the whole viscus is converted into a mass of growth containing the gall-stones. The fungating type of carcinoma is at first a tumour which rises abruptly from an otherwise normal mucous membrane, infiltration being limited to the area occupied by its base. It tends to assume a papillary form. Both infiltrating and fungating types of growth, if they begin in the neck of the gall-bladder, may block its outlet and cause distension.

The cells composing a carcinoma of the gall-bladder may be either columnar or spheroidal, both forms being found in the same growth as a rule. The papillary types are often composed of columnar cells, but in their deeper parts the epithelium tends to become spheroidal, with considerable formation of fibrous tissue. Colloid and other forms of degeneration occur, but are not specially common.

The characteristic method of extension of carcinoma of the gall-bladder is by direct growth into the liver, and the liver is also the chief site of metastases. The growth may also spread along the bile-ducts, and constantly involves the portal lymphatic glands.

Carcinoma of the bile-ducts is also associated with gall-stones, though by no means to the same extent as is carcinoma of the gall-bladder. It is rather more common in men than in women. The most common sites of origin are at the lower end of the common duct, and at the junction of the hepatic, cystic, and common ducts. The growth is usually a small one, and forms an annular stricture, but may spread for a considerable distance along the wall of the duct. It may also assume a papillary form. Histologically, the growth is composed of columnar cells. Whether the gall-bladder is distended or not depends upon the site of the growth and upon the presence or absence of pre-existing cholecystitis. The bile-ducts above the tumour are necessarily dilated.

CARCINOMA OF GALL-BLADDER. GALL-STONES.

One-half of an enlarged gall-bladder, together with a portion of the transverse colon.

At the upper end of the specimen is the ligatured stump of the cystic duct. The gall-bladder is filled with tightly packed cholesterin stones. At the fundus is a malignant growth, part of which projects into the cavity and part of which has perforated the wall and is attached to the transverse colon. The growth shows extensive necrosis.

Hunterian Museum, R.C.S. 1766.1

MICROSCOPIC STRUCTURE.—Columnar-celled carcinoma.

CLINICAL HISTORY.—The patient was a woman, aged 43, who complained of a hard swelling under the right costal margin. There was a dragging sensation, but no actual pain, nor was there any jaundice.

On examination, the swelling was dependent from the liver and moved freely with respiration. The specimen shown was removed by operation, but the growth also implicated the stomach and duodenum. Abdominal recurrence occurred in two months and the scar became infiltrated by growth. The patient died fourteen weeks after the operation.
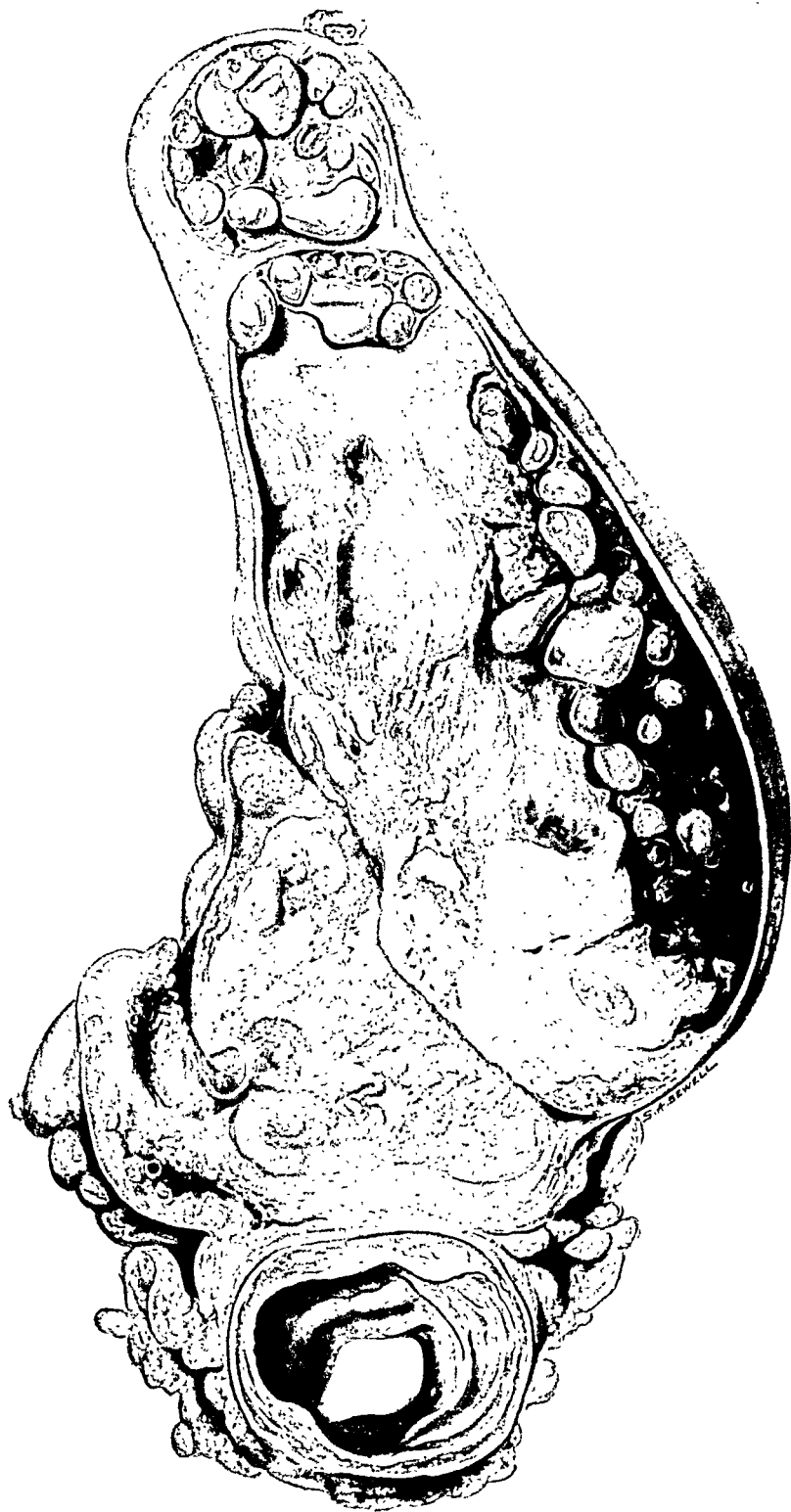
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Atlas of Pathological Anatomy

CARCINOMA OF GALL-BLADDER. GALL-STONES.

A gall-bladder with the adjacent portion of the liver divided by longitudinal section.

The wall of the gall-bladder is infiltrated by an ill-defined growth originating in the mucous membrane and associated with many small stones. The adjacent liver is invaded by direct extension, and several metastatic deposits are present at a distance.

Hunterian Museum, R.C.S. 1864.1

MICROSCOPIC STRUCTURE.—The tumour is composed of narrow columns of cells, the larger collections of which present a lumen surrounded by cells of columnar shape.

CLINICAL HISTORY.—The patient was a woman, aged 61, who died a few days after admission to hospital. Thirty years before she had been jaundiced, and since that time she had had frequent attacks of biliary colic.

On admission to hospital she was tender over the gall-bladder. She developed jaundice with severe pain the day before death.

AUTOPSY.—There were numerous adhesions round the liver. The cœliac and hepatic lymph glands contained growth. There was no disease elsewhere in the abdomen or thorax.

409

CARCINOMA OF GALL-BLADDER. GALL-STONES.

A gall-bladder opened to show a small fungating tumour on the inner surface.

The tumour involves the wall near the fundus and appears beneath the peritoneum. A lymph gland close to the cystic duct shows secondary involvement by degenerated growth. The gall-bladder contains five mixed calculi, each about the size of a cherry stone.

Museum of the College of Medicine, University of Durham, Newcastle-upon-Tyne, 383/25

MICROSCOPIC STRUCTURE.—Columnar-celled carcinoma. The lymph gland contains secondary growth.

CLINICAL HISTORY.—The patient was a woman, aged 59, who complained of attacks of abdominal pain for twelve months. The pain began in the epigastrium and radiated to the right shoulder. The gall-bladder was removed by operation. No after-history.
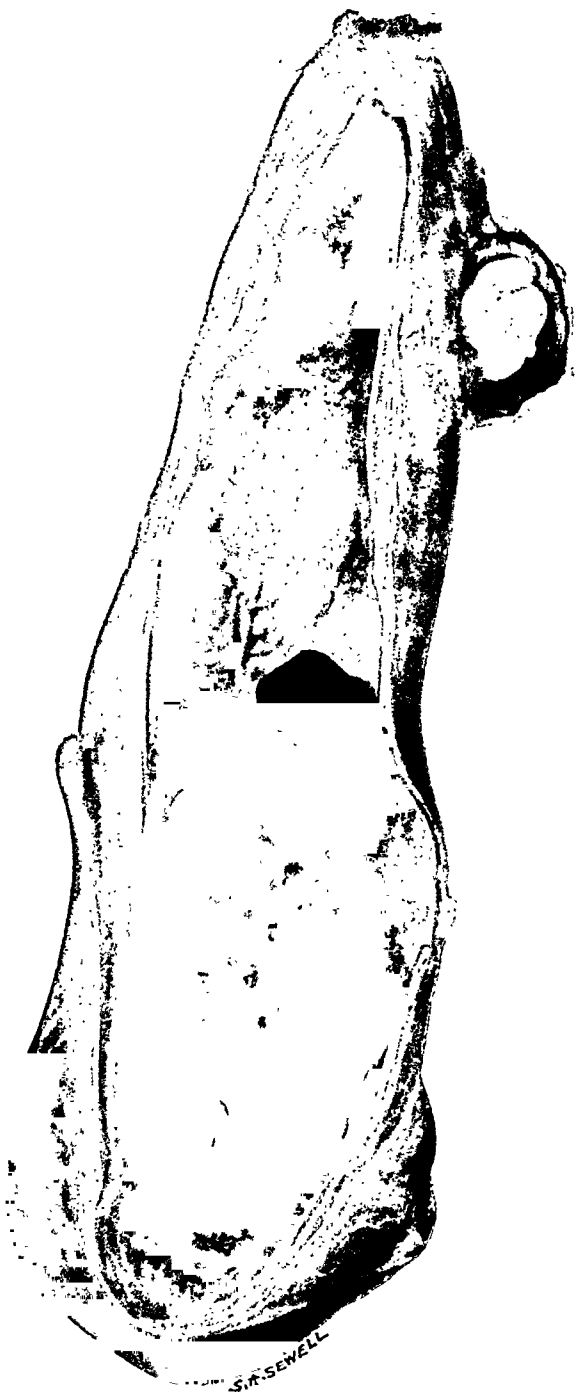
S.A. SEWELL

411

CARCINOMA OF GALL-BLADDER.

A gall-bladder divided by longitudinal section, together with a portion of liver.

The wall of the gall-bladder is of normal thickness except at the site of the tumour. At the fundus it is greatly thickened by a white growth which is infiltrating the liver. The outer surface of the growth is nodular. Two small, faceted gall-stones have been left in the gall-bladder.

Pathological Museum, University of Sheffield, K. XIV. 24

MICROSCOPIC STRUCTURE.—Carcinoma.

CLINICAL HISTORY.—The patient was a woman, aged 54, who had had typical attacks of cholecystitis for ten years. Before operation, the attacks had been more frequent and more severe.

On examination, the signs were typical of subacute cholecystitis, and the gall-bladder was felt.

The gall-bladder, filled with stones, together with the portion of the liver involved in the growth, was removed successfully by operation. No after-history.
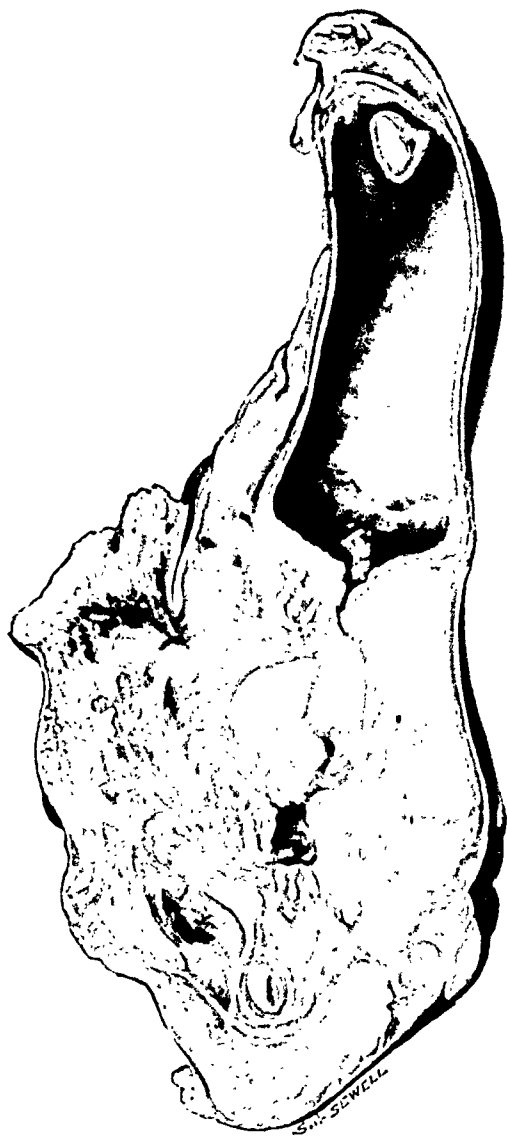
413

ACUTE CHOLECYSTITIS. GALL-STONE.

A gall-bladder divided by longitudinal section.

The peritoneal surface is congested as the result of acute inflammation. The wall is thickened. An oval calculus, composed of radiating crystals of cholesterin, is impacted at the neck, and the cavity of the gall-bladder is occupied by bile-stained mucus and recently effused blood.

Pathological Museum, University of Sheffield, K. VI. 11

CLINICAL HISTORY.—The patient was a woman, aged 35, who complained of epigastric uneasiness and nausea fourteen days before admission to hospital. There was severe vomiting four days before admission. She had never had real biliary colic, nor had she been jaundiced.

On admission, she presented the clinical picture of acute cholecystitis. The gall-bladder was successfully removed by operation.

415
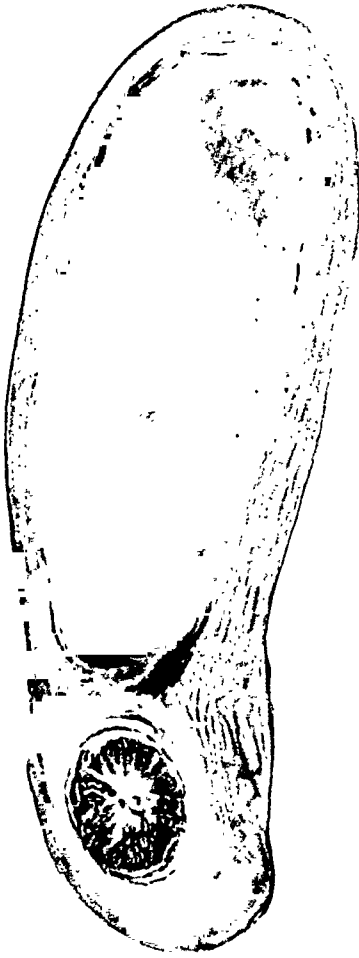
CHOLECYSTITIS. GALL-STONES.

('STRAWBERRY GALL-BLADDER.')
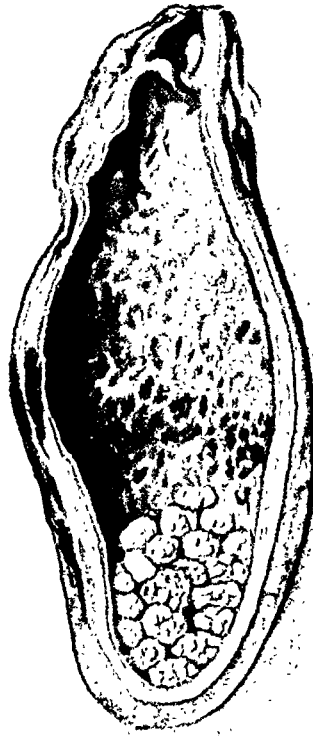
A gall-bladder which has been opened.

The gall-bladder is of normal size. Its wall is slightly thickened and inflamed. The peritoneal surface is inflamed, but there is no exudation of lymph. The mucous membrane is hyperæmic and is thrown into folds, the crests of which are yellow from the deposit of cholesterin. Numbers of bramble-like cholesterin calculi, many of them bile-stained, are lying in the fundus.

Museum of the College of Medicine, University of Durham, 382/20

CLINICAL HISTORY.—The patient was a woman, aged 26, who for some months had suffered from attacks of gall-stone colic, associated with mild cholecystitis. She was admitted to hospital during an attack of unusual severity.

The gall-bladder was removed by operation and the patient made a good recovery.

J.A.SEWELL
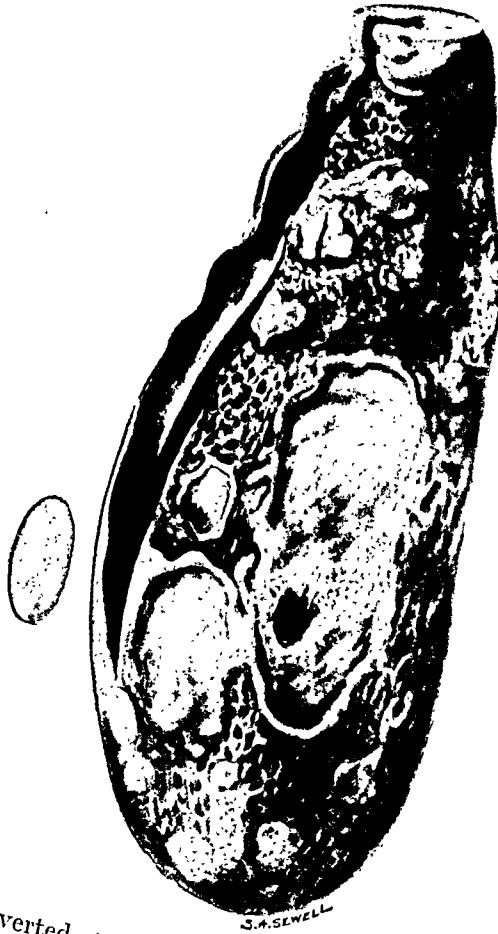
A gall-bladder inverted, together with a small calculus.

The walls of the gall-bladder are thickened and injected as the result of acute inflammation. At several places the mucous membrane is necrotic and bile-stained. Some of the necrotic areas have been detached, and there is a perforation at the site of the largest slough.

Hunterian Museum, R.C.S. 689.1

CLINICAL HISTORY.—The patient was a man, aged 38, who presented symptoms of a sudden perforation of the gall-bladder.

NO. 18—SUPPLEMENT

S

Atlas of Pathological Anatomy

ACUTE CHOLECYSTITIS WITH STONE.

A gall-bladder opened by longitudinal incision.

The gall-bladder is greatly enlarged and its wall is thickened. The mucous membrane is intensely engorged and, in places, ulcerated. A stone is impacted in the opening of the cystic duct. The peritoneal surface is injected.

The gall-stone is composed of cholesterol, and appears to be made up of many smaller ones welded together by fresh deposits of cholesterol.

Museum of St. Bartholomew's Hospital, N.200

MICROSCOPIC STRUCTURE.—The wall of the gall-bladder shows a state of acute inflammation everywhere. The muscular coat is thickened by œdema, and the submucous and subperitoneal tissues are extremely congested.

CLINICAL HISTORY.—The patient was a woman, aged 25. Three days before admission to hospital she had had an acute attack of abdominal pain, at first epigastric, but later localized to the right iliac fossa. The pain continued, with vomiting and constipation, but without colic, flatulence, or jaundice.

The gall-bladder was removed by operation.

CHOLECYSTITIS. GALL-STONES.

A gall-bladder opened by longitudinal incision of its hepatic surface.

The gall-bladder is moderately enlarged, and is completely filled by a large number of small, yellow, faceted calculi. The peritoneal coat is slightly thickened, but shows no sign of recent peritonitis.

Museum of St. Bartholomew's Hospital, N.209

MICROSCOPIC STRUCTURE.—There is very little evidence of inflammation of the mucous or peritoneal coat of the gall-bladder, but a few collections of small round cells are seen among the fibres of the muscular coat.

CHEMICAL EXAMINATION.—The stones consist almost entirely of cholesterol, with a trace of bile pigment.

CLINICAL HISTORY.—The patient was a man, aged about 40, who had had attacks of colic with gradually increasing frequency for two years. The pain had been situated in the middle line or a little to the left of it. There had been no jaundice since childhood. The appendix had been removed twelve years before. The condition was not detected by X-ray examination. The pain ceased after removal of the gall-bladder.
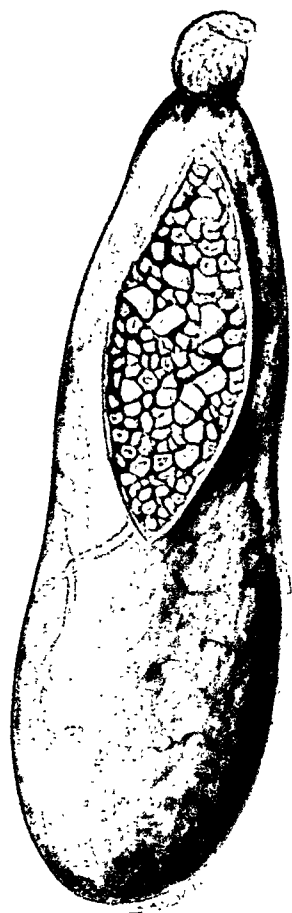
NO. 18—SUPPLEMENT

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ACUTE CHOLECYSTITIS. GALL-STONE.

A gall-bladder divided by longitudinal section.

The gall-bladder is enlarged and acutely inflamed. The peritoneal coat is flushed, the wall is thickened by œdema, and the lumen is filled by blood, mucus, and a large calculus.

Museum of University College Hospital, 11.X.2

MICROSCOPIC STRUCTURE.—Acute inflammation of the wall of the gall-bladder.

CLINICAL HISTORY.—The patient was a woman, aged 52, who for three days had had severe griping pain in the right side of the abdomen and back and over the right shoulder-blade. The pain was aggravated by movement or by drinking. There had been neither vomiting nor any symptoms pointing to antecedent cholelithiasis.

On admission to hospital the temperature was 98·4° and the pulse 76. On the following day the temperature rose to 101° and the pulse to 92. The abdomen was opened on the fifth day after admission and the gall-bladder was removed. The patient left the hospital nineteen days later, with the wound healed.
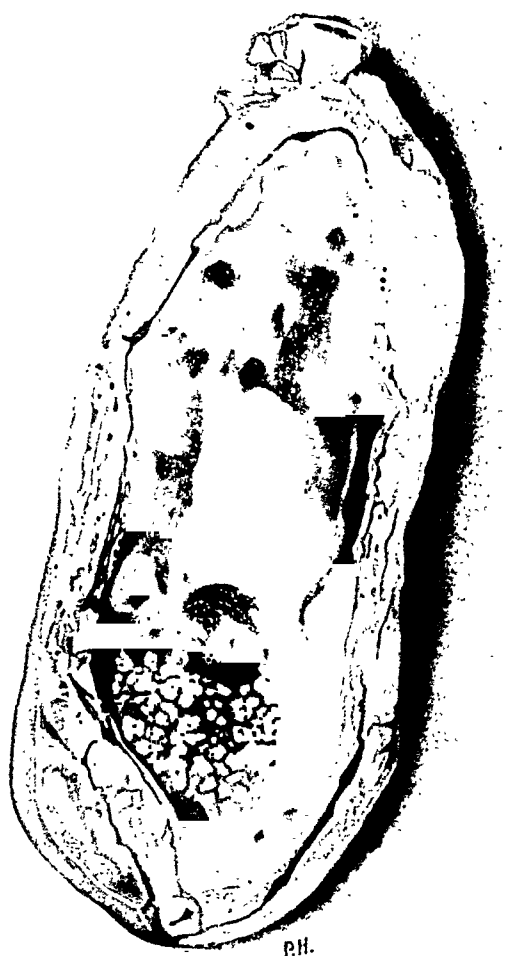
GALL-STONES.

A gall-bladder opened to show its contained stones.

The wall of the gall-bladder is thick but shows no signs of recent inflammation, nor are there any peritoneal adhesions. Its lumen is closely packed with many small, faceted, cholesterin calculi. A larger calculus of the same composition is impacted in the cystic duct.

Museum of the College of Medicine, University of Durham, Newcastle-upon-Tyne, 382/18

CLINICAL HISTORY.—The specimen was removed post mortem from a man who died of perforation of an aortic aneurysm. There were no symptoms referable to the gall-stones.
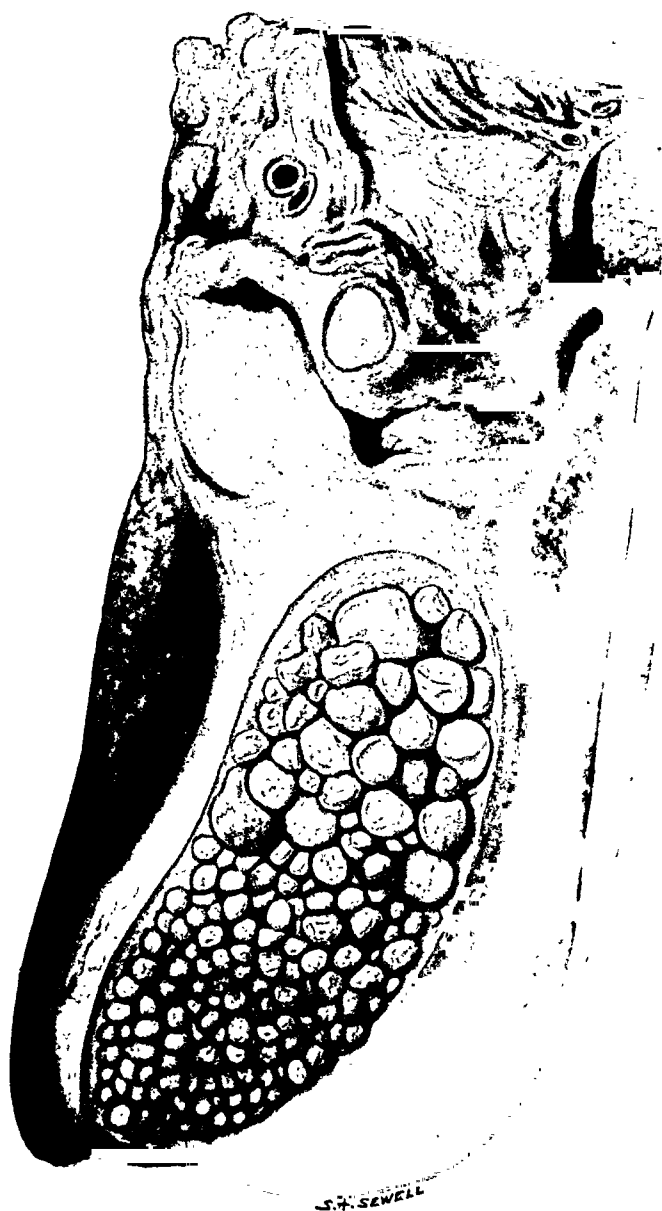
S.T. SEWELL

DUODENAL FISTULA.

A gall-bladder with the adjacent portions of the liver and duodenum.

The gall-bladder is not visible on the side from which the specimen has been drawn, but is united to the duodenum by inflammatory adhesions.

The duodenum has been opened along the front to show a gall-stone in the act of ulcerating through from the gall-bladder.

Museum of University College Hospital, 12.X.2

CLINICAL HISTORY.—The patient was a woman, aged 53, who had had six children and had always been healthy. For ten weeks before her death she had complained of pain after food and flatulence, and she had been treated for this in the out-patient department. One week before death she began to vomit, became constipated, and passed less and less urine. Forty-eight hours before death she was admitted to hospital with suppression of urine. She died in coma.

AUTOPSY.—One gall-stone in the position shown by the specimen. Another stone, 1½ in. in diameter, lay in the duodenum. The liver was fatty, and there was parenchymatous degeneration of the kidneys.

S. A. SEWELL

427
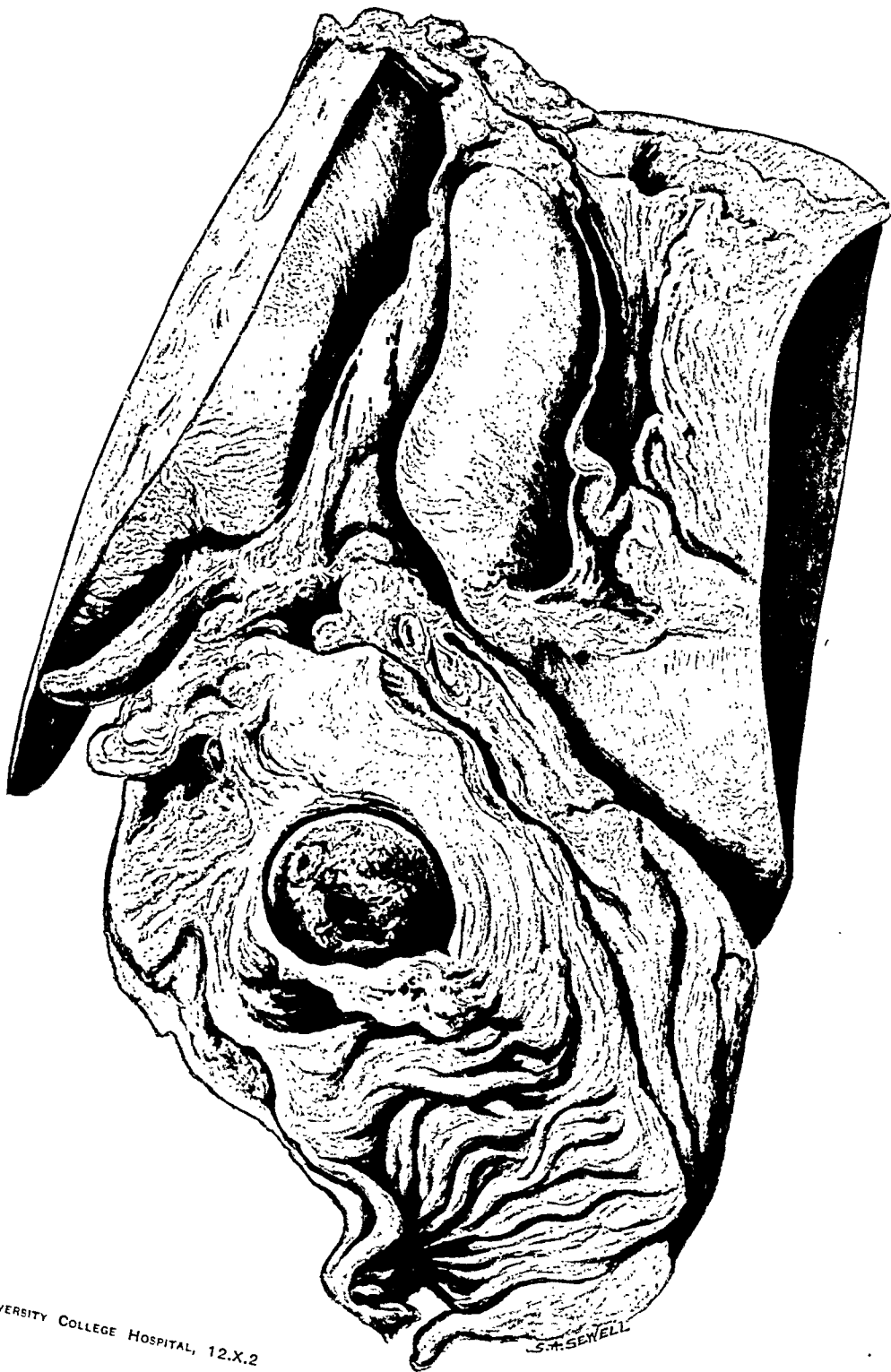
DUODENAL FISTULA.

Part of a liver, seen from below, with the gall-bladder and duodenum.

The common bile-duct is distended and contains several calculi. Its common opening with the pancreatic duct into the duodenum is marked by a glass rod in each duct. The gall-bladder is thickened and shrunken and has become adherent to the duodenum, and a large fistulous opening has been formed between them. The gall-stone shown beside the specimen passed through this opening.

Museum of St. Bartholomew's Hospital, N.230

CLINICAL HISTORY.—The patient was a woman, aged 76, who died from intestinal obstruction caused by lodgement of the stone in the lower part of the ileum.
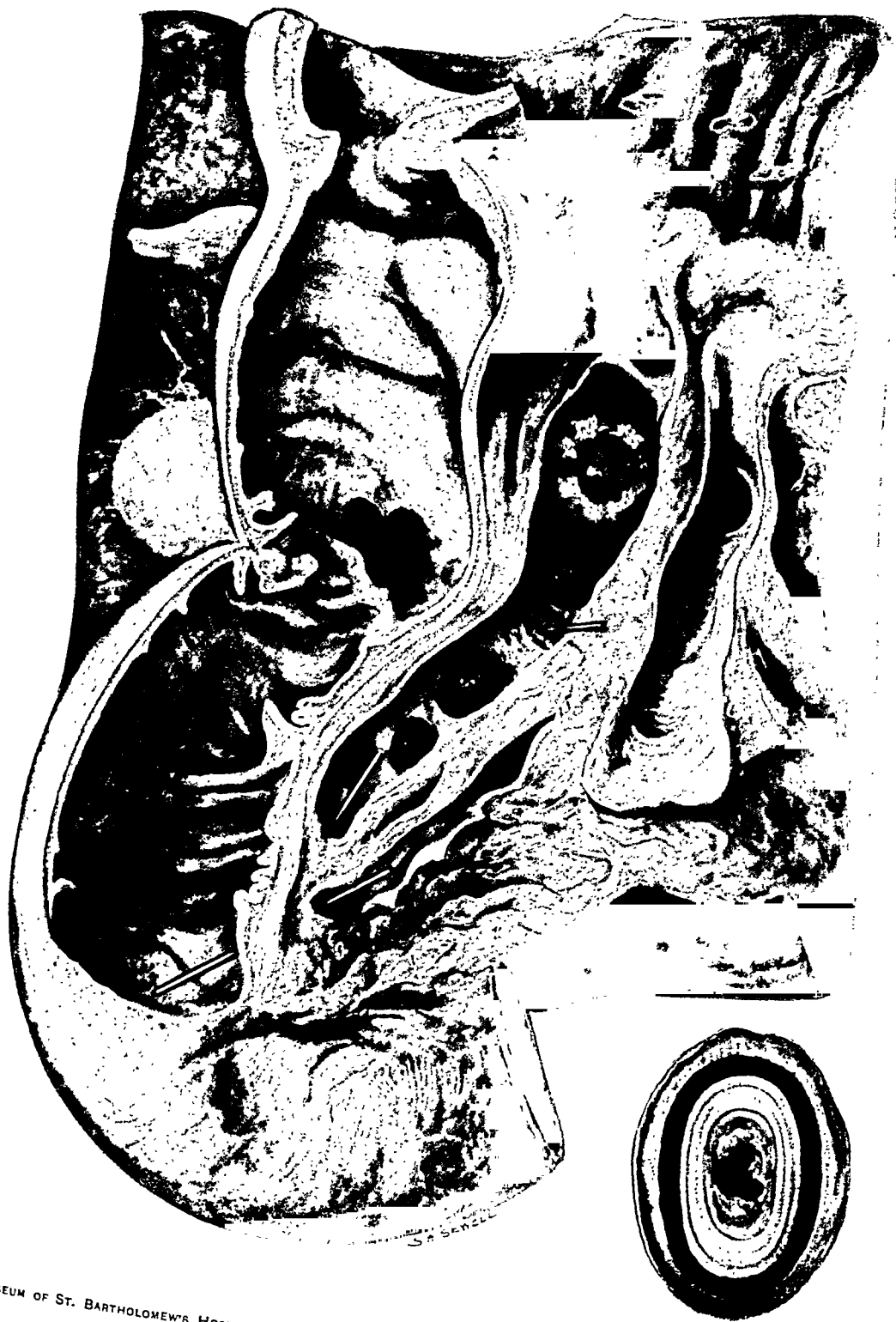
GALL-STONES.

(ACUTE PANCREATITIS.)

A pancreas with portions of the liver and duodenum, dissected from behind.

The gall-bladder is shrunken through chronic inflammation and a stone is impacted at its neck. The common bile-duct is dilated from impaction of a stone at its duodenal end. A second stone, impacted in the ampulla of Vater, has blocked the pancreatic duct, which is dilated and stained by bile. The pancreas contains necrotic areas, some of which are hæmorrhagic, others bile-stained. There is fat necrosis in its neighbourhood. The pancreatic tributaries of the splenic v in, and the splenic vein itself, are thrombosed.

Museum of St. Bartholomew's Hospital, N.282

MICROSCOPIC STRUCTURE.—Many of the smaller pancreatic ducts are distended with bile and surrounded by areas of necrosis. Into some of these areas hæmorrhage has occurred.

CLINICAL HISTORY.—The patient was a woman, aged 40, who had suffered from indigestion for four years. For three days before admission to hospital she had had abdominal pain, flatulence, and thirst, and had been constipated. On admission the upper abdomen was tender and rigid and there were signs of free fluid in the peritoneal cavity.

On operation the gall-bladder, which contained pus and stones, was drained. The peritoneal cavity contained bile-stained fluid, but no fat necrosis was seen. The pancreas was hard. Death occurred ten hours later.

A. K. MAXWELL
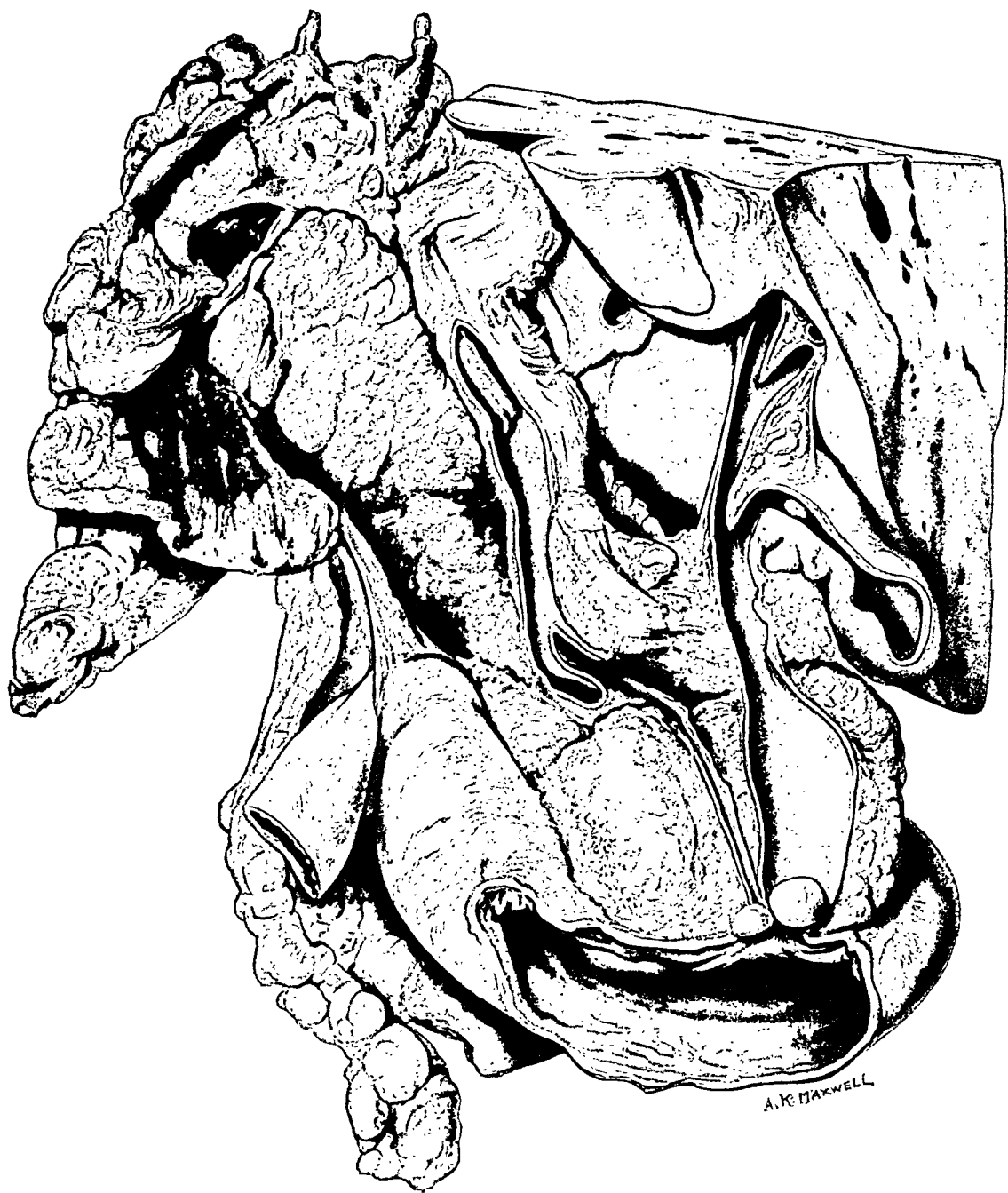
GALL-BLADDER. STRANGULATION BY BAND.

A gall-bladder, opened by incision, with the cystic duct. The constricting band is shown at the side.

The mark of the constricting band is clearly visible across the neck of the gall-bladder. On its distal side the gall-bladder is reddened by venous congestion and its wall is thickened by inflammatory exudate. Some adhesions are attached to the peritoneal surface near the site of constriction.

Museum of University College Hospital, 2.X.1

CLINICAL HISTORY.—The patient was a woman, aged 32, who complained of severe abdominal pain and retching for two days. Similar attacks had occurred eight years and four weeks before. The attack eight years before had been diagnosed as caused by gastric ulcer.

On admission to hospital she was very ill, with a slightly distended abdomen, in which could be felt a tender swelling to the right of the umbilicus. Temperature 100°, pulse 132.

At operation there was blood-stained fluid in the abdomen. The gall-bladder was almost black, and was tightly strangulated at its neck by adhesion. Cholecystectomy. The patient left the hospital three weeks later.

S A SEWELL

433

## PAPILLOMA OF GALL-BLADDER. STONE.

A gall-bladder opened by longitudinal incision.

One inch from the commencement of the cystic duct the mucous membrane of the gall-bladder is replaced by an annular, papillary growth, half an inch in width. The wall of the gall-bladder opposite to the growth is thickened by fibrous tissue, but there is no infiltration of the submucosa by tumour. The gall-bladder is of normal size, and, apart from the area occupied by the papilloma, its walls are of normal thickness. It contains a single, hard, nodular, bilirubin-calcium stone.

Museum of University College Hospital, 15.X.1

MICROSCOPIC STRUCTURE.—The tumour is composed of delicate fibrous-tissue processes covered by a layer of regular columnar epithelium.

CLINICAL HISTORY.—The patient was a married woman, aged 44, on whom a gastro-jejunostomy was performed for pyloric stenosis. The gall-bladder was removed because it contained a stone, and the existence of the papilloma was not suspected until the specimen was opened. The patient made a good recovery.

S. H. SEWELL
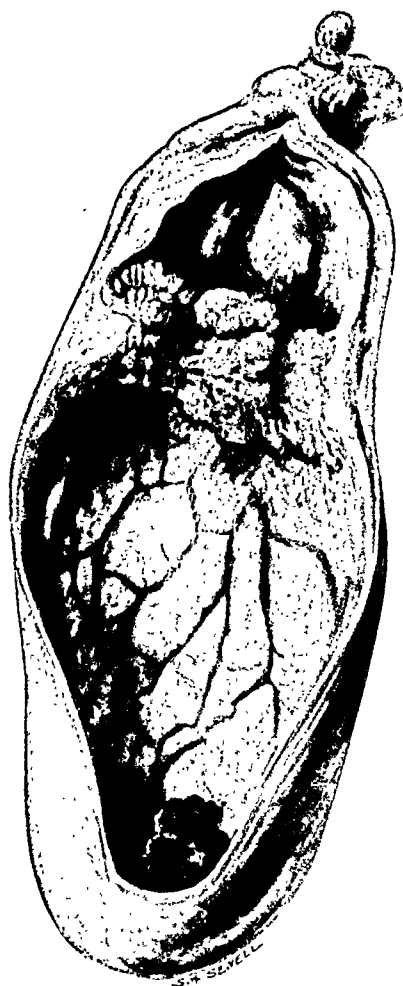
CARCINOMA OF THE BILE-DUCTS.

A gall-bladder with the cystic and common bile-ducts and a portion of the liver. The gall-bladder and bile-ducts have been opened by longitudinal incision.

The gall-bladder contains inspissated mucus and blood-clot. At its neck the wall is thickened and invaded by a growth which extends to and blocks the cystic duct and projects from its lower end as a fungating tumour into the common bile-duct. The papillary character of the growth is best seen in this projecting mass.

In consequence of the obstruction of the common bile-duct by growth, the intrahepatic bile-ducts are dilated and the liver is jaundiced. There is no suppuration in the intrahepatic bile-ducts. A few secondary nodules of growth are present in the liver near the gall-bladder.

Museum of University College Hospital, Alim. W.6

CLINICAL HISTORY.—The patient was a woman, aged 55, who had had epigastric pain for four months and jaundice with white stools for two months.

437

CYSTIC DILATATION OF THE COMMON BILE-DUCT.

The upper abdominal viscera of a child seen from behind.

In relation to the under surface of the liver is a greatly distended common bile-duct with thick, tough walls. The duodenum is moulded to its outline. A slit-like tortuous passage leads from the bile-duct to the duodenum. The openings of the two hepatic ducts are seen above. The bristle lies in the pancreatic duct and marks the position of the ampulla of Vater. The liver is firm and shows evidence of diffuse fibrosis. The spleen is enlarged.

Museum of St. Bartholomew's Hospital, N.197

MICROSCOPIC STRUCTURE.—The wall of the bile-duct is composed of dense fibrous tissue. In places flattened epithelial cells from an imperfect lining to the cyst. The liver shows diffuse portal cirrhosis and there is fibrosis of the spleen.

CLINICAL HISTORY.—The patient was a girl, aged 2 years. For a month enlargement of the abdomen had been noticed, and for a fortnight vomiting, chiefly nocturnal without relation to food. There had been a brief attack of jaundice at the age of nine months.

On examination the cyst, which occupied most of the right side of the abdomen, was thought to be connected with the kidney, but its nature was ascertained by examination of the fluid withdrawn at laparotomy. The cyst was drained, but the child's condition made further operation impossible, and she died three weeks later.

(Brit. Med. Jour. 1925, ii, 991.)

S.A.SEWELL

STENOSIS OF GALL-BLADDER.
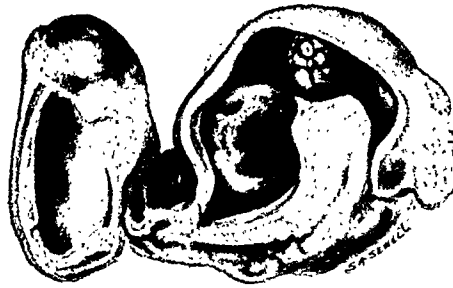
A gall-bladder divided by longitudinal section.

The gall-bladder is constricted near its middle by a scar so as to be divided into two parts.   In the half from which the cystic duct arises are two calculi.

Pathological Museum, University of Liverpool B.104

CLINICAL HISTORY.—The patient was a woman, aged 31, whose gall-bladder had been drained after an attack of biliary colic six months before.
On admission to hospital there was a sinus discharging mucus in the scar of the previous operation.   The gall-bladder was removed.

XX. INFLAMMATION OF BONE.

ACUTE SUPPURATIVE OSTEOMYELITIS.

(*Acute Necrosis.*)

THIS serious and common disease is due to infection of an intact bone through the blood-stream. It mainly affects the growing bones of adolescents before the junction of the epiphyses with the shafts, and commences on the diaphysial side of the epiphysial line. From this point the infection spreads freely along the diaphysis, but is checked on the epiphysial side by the resistance of the epiphysial cartilage. Boys are affected more often than girls. The common causative micro-organism is the *Staphylococcus pyogenes aureus*, which reaches the blood through the skin. It may have an obvious source, as in a septic abrasion, boil, or patch of impetigo, but there is often no demonstrable site of entry. A slight injury to the affected bone may precede the onset of the disease, or the general health of the patient may be temporarily lowered, as by scarlet fever.

Acute osteomyelitis may start in the neighbourhood of any epiphysis, but those most often affected are the epiphyses of the long bones. If the epiphysial line involved lies within the capsule of a joint, as in the case of the head of the femur, suppurative arthritis is a necessary concomitant. If the capsule of the joint is attached on the epiphysial side of the line, as at the upper end of the tibia, the joint usually escapes infection, though it is frequently distended by a serous effusion excited by toxins from the adjacent focus of suppuration.

Acute osteomyelitis is sometimes due to organisms other than the *Staphylococcus aureus*, particularly in adults, in whom any part of a bone may be attacked.

In infants acute osteomyelitis not uncommonly commences on the epiphysial side of the epiphysial line (acute epiphysitis). The infection may extend into the neighbouring joint by perforating the articular cartilage, or the whole epiphysis may necrose and form a sequestrum.

The septicæmic nature of acute suppurative osteomyelitis at its onset is indicated, in the most severe forms of the disease, by the simultaneous appearance of multiple foci in bones and joints, and by suppuration in the serous cavities before death. In such cases bacteria can usually be cultivated from the blood. Even in cases which do not end fatally, it is not uncommon for foci of suppuration to appear at intervals in bones, joints. or cellular tissues (e.g., perinephritic abscess) some time after the original site of infection has been adequately drained by operation.

The soft tissues of the body, when inflamed. can accommodate themselves to the extra pressure of the exudate by swelling. and inflammation can, therefore, only cause their destruction through intensity of microbic poison. Bone is unable to swell when inflamed, and. as a consequence, is subject not only to the toxic effect of the invading bacteria, but also to strangulation of

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its vascular supply by the pressure of the exudate. This inability to accommodate itself by swelling is the chief reason why bone is more prone to destruction by inflammation than any other tissue. The compactness of structure of bone, and the ease with which its vascular supply, though free, can be interrupted, make the spread of inflammation so rapid as often to appear simultaneous in all its components—periosteum, compact layer, cancellous tissue, and marrow. This does not mean that the whole of a bone becomes inflamed at one and the same moment, but that all its constituent tissues become inflamed together at whatever part of the bone inflammation commences.

The sequence of local pathological changes in acute suppurative osteomyelitis commences with a stage of destruction, which, in surviving cases, is succeeded by a stage of repair. At any point the evolution of the disease may be interrupted by surgical interference.

Stage of Destruction.—Acute suppurative osteomyelitis commences with infection of the whole area of cross-section of the diaphysis close to the epiphysial cartilage. It is probable that the marrow is attacked first, but the freedom with which the vascular channels of the bone communicate with one another and the rigidity of their walls make the spread of infection outwards to the periosteum so rapid that the whole thickness of the bone is involved from the beginning.

The epiphysial cartilage forms a barrier which, in most cases, saves the epiphysis and neighbouring joint from infection. Starting from this barrier a wave of staphylococci advances along the medullary cavity, leaving in its train thrombosis of vessels and suppuration in the marrow. It is on account of the thrombosis of its vessels that infected marrow does not bleed when exposed at operation. In the most acute cases, the marrow, when exposed, is of a dull red colour and exudes drops of liquid fat. The periosteum is at first thickened by inflammatory exudate and later raised from the bone by the formation of pus between the two. This process of separation of the periosteum commences opposite the site of primary infection, and travels along the shaft at a rate somewhat slower than that of the medullary inflammation. It is often accelerated by the pressure of pus, which can be seen at operation oozing out of the medulla through one of the larger vascular channels in the compact bone. In severe cases, the shaft is at first denuded of periosteum around its whole circumference only at the end where the disease commenced, the remainder of the bone retaining a partial periosteal covering ; but, if operation has been long delayed, the entire diaphysis may be found bare and dead in a bath of pus.

From the pus beneath the periosteum toxins diffuse into the surrounding soft parts and excite an œdema, which is followed by abscess-formation as soon as the periosteum is perforated. The pus which escapes from the bone may, but does not necessarily, take the shortest route to the surface, as it is sometimes so deflected by connective-tissue planes as to appear, on superficial inspection, to arise from a neighbouring bone—e.g., at the ankle or in the forearm ; or it may even appear to be caused by a different disease, as in the case of osteomyelitis arising in the epiphysis of the iliac crest, which, by forming an abscess in the right iliac fossa, may simulate appendicitis.

Stage of Repair.—If the patient survives and tension is released by the discharge of pus on the surface of the body, the dead portion of bone (*sequestrum*) is separated by ulceration of the layer of living bone in immediate contact with it, and, after about six weeks, lies loose in an abscess-cavity whose walls are formed by the granulation tissue which lines the periosteal tube. While the sequestrum is being separated new bone is being formed by the osteoblasts which have remained adherent to the detached periosteum, so that a bony cylinder, the *involucrum*, is ready to maintain the continuity of the shaft. The walls of the involucrum are rough and irregular and perforated by holes—the *cloacæ*—through which pus escapes towards the surface. A cloaca in an involucrum is the equivalent of a sinus in the soft parts.

Complications of Acute Suppurative Osteomyelitis arising by Local Spread of Infection.—The epiphysial cartilage may be partly destroyed so that infection extends to the epiphysis. The neighbouring joint may be infected by perforation of the articular cartilage or by extension of inflammation outside the bone without involvement of the epiphysis. On account of the frequency with which a clear, or even turbid, effusion is present, no conclusion can be drawn from mere distension of the joint in the absence of positive demonstration of the presence of bacteria within that effusion.

Septicæmia.—Reference has already been made to the septicæmic nature of acute suppurative osteomyelitis at its onset. The most important manifestations are the affection of several bones, suppuration in joints and serous cavities, and perinephritic abscess. In fatal cases petechial hæmorrhages and thrombotic hemiplegia have been observed. A common characteristic of the multiple infections of acute osteomyelitis is their tendency to be of a lower grade of virulence than the primary focus. It is not uncommon for convalescence to be interrupted by the surreptitious appearance of abscesses arising in bones which, when investigated, bear the marks of an infection of considerable duration. It is in this way that a Brodie's abscess often arises, only to lie dormant, and awake to clinical activity after the lapse of years.

Effects of Surgical Intervention.—The spread of infection in osteomyelitis is mainly conditioned by the inability of the marrow to swell within the rigid bone, and this factor can immediately be abolished by establishment of adequate surgical drainage. The term 'adequate' implies exposure to the surface of the whole area of infection of soft parts, periosteum, and marrow. During the stage of repair, restoration of structural and functional integrity to the bone is dependent on removal of the sequestrum and obliteration of the cavity in which it lay.

CHRONIC SEPTIC OSTEOMYELITIS.

Under this heading are included the chronic infections of bone caused by the ordinary bacteria of suppuration. They represent a type of inflammation which differs from that of acute suppurative osteomyelitis only in the lesser virulence of the invading organism and in the correspondingly slight reaction of the bone to its activities. The *Staphylococcus aureus* is as predominant a cause as in the acute variety.

In chronic septic osteomyelitis the affected bone usually contains either a sequestrum or a cavity. There may or may not be a sinus in each case. Many examples of both conditions represent previously unrecognized foci secondary to acute suppurative osteomyelitis elsewhere. A small sequestrum formed in this way may become completely enclosed in a thick shell of dense bone. A more common condition is the encysted abscess—Brodie's abscess —which is similarly enclosed by a thick wall of sclerosed bone.

Brodie's Abscess may occur at the extremity of any long bone, which in consequence becomes enlarged by the deposition of new subperiosteal bone. The central cavity contains pus, enclosed by a densely sclerosed wall with a lining of granulation tissue. After a period of quiescence extending often over many years, a sequence of exacerbations and remissions develops. In one of the exacerbations a sinus may open. Once formed, it rarely heals of its own accord. X rays show a cavity surrounded by a ring of sclerosed bone.

PERIOSTITIS.

In a strict sense inflammation of the periosteum does not occur without inflammation of the underlying bone. There are, however, certain conditions in which the significant changes are so limited to the subperiosteal strata as to justify their inclusion under the heading of periostitis rather than under that of osteomyelitis. Chronic periostitis may follow injury of a severity insufficient to cause fracture, or suppuration may result from infection of a subperiosteal hæmatoma. In the latter case there is usually necrosis of the superficial strata of the bone. A circular, raised plaque of new subperiosteal bone is often formed on the tibia beneath a chronic ulcer of the leg, and thickening of the ribs overlying a chronic empyema has been noted.

In the condition known as 'hypertrophic pulmonary osteo-arthropathy', concentric rings of subperiosteal bone are laid down at the peripheral extremities of the long bones of the limbs. The stimulus to the production of the new bone appears to be a toxin, which may arise in any suppurative focus of long standing—not necessarily in the lungs. Associated changes in the joints rarely, if ever, occur. The new bone may be reabsorbed if the underlying disease improves.

TYPHOID OSTEITIS.

During an attack of typhoid fever one or more bones may be infected by bacteria of enteric origin, either of the coliform group, including *B. typhosus*, or of the staphylococcal or streptococcal variety, alone or in combination. The results of infection may become apparent during the later weeks of the disease, or only after the lapse of months or years. No age is exempt, but the condition is common in young subjects.

The pathological lesion varies from a superficial periostitis to a central bone abscess. A sequestrum is uncommon.

ACUTE OSTEOMYELITIS.

The first metatarsal bone of the right foot of a child.

The shaft is reddened and is completely denuded of periosteum. The epiphysis at the base is separated.

Museum of St. Bartholomew's Hospital, A.79

CLINICAL HISTORY.—The patient was a girl, aged 11 years, whose right foot became inflamed and painful six days before she was admitted to hospital with general septicæmia. The foot was incised and drained, but pleurisy. bronchopneumonia, and pericarditis supervened, and death occurred two days after admission. Streptococci were cultivated from the blood during life.

ACUTE OSTEOMYELITIS.

A section through the upper extremity of a tibia.

The periosteum is separated from the surface of the bone. A surgical opening, communicating with the medulla, shows the recent exudation of lymph. On the cut surface of the cancellous bone of the upper end of the shaft, the metaphysis is of an intense red colour and is studded with areas of pus. The cancellous bone of the epiphysis shows no special change.

Museum of the College of Medicine, University of Durham, Newcastle-upon-Tyne, 600/63

CLINICAL HISTORY.—The patient was a boy, aged 13 years, who was admitted to hospital acutely ill and died from pyæmia a few days after operation.
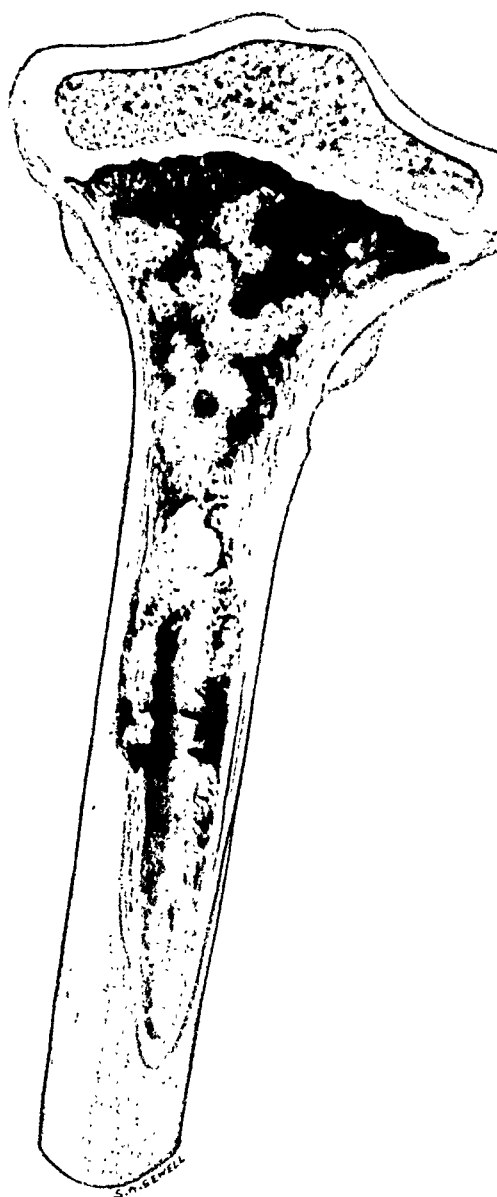
ACUTE OSTEOMYELITIS.

The upper part of a left femur divided by longitudinal section.

The marrow is injected throughout its whole length and contains many abscess cavities. Above the level of the medullary canal the cancellous bone of the trochanter and neck is irregularly mottled by yellowish areas of pus.

Museum of University College Hospital, 50.A.1

CLINICAL HISTORY.—The patient was a man, aged 28, who had had osteomyelitis of the left thigh 11 years before. On admission to hospital there was a large abscess on the outer side of the left femur, apparently subperiosteal in position. The pus from this spread into the muscles of the thigh before it was drained. At a subsequent operation the femur was opened and the marrow was found to contain pus. The patient developed pyæmia and swelling of both legs before death.

AUTOPSY.—The whole length of the medullary canal of the femur was full of pus. There was thrombosis of the femoral and iliac veins on both sides, pus in the pleural and pericardial cavities, and pyæmic abscesses in the lungs.

Atlas of Pathological Anatomy
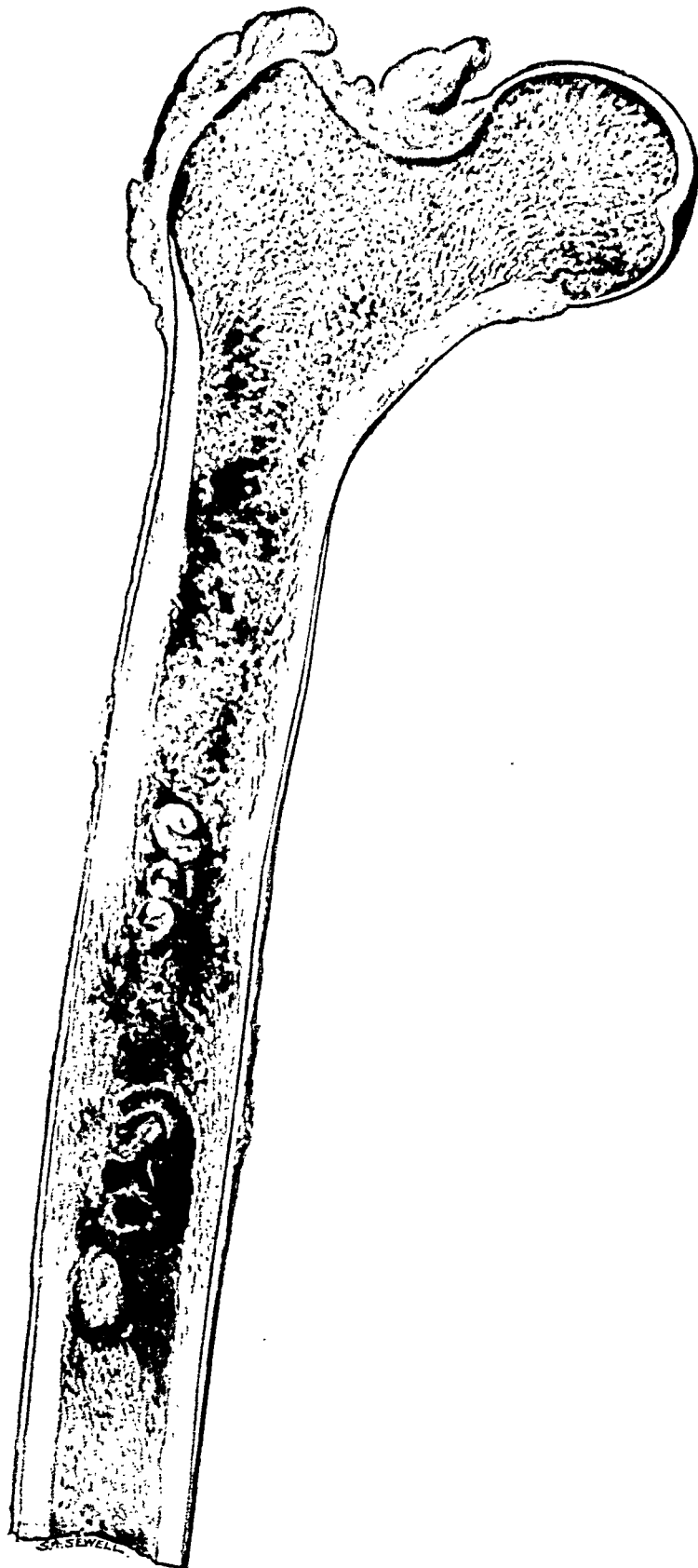
ACUTE OSTEOMYELITIS.

The lower half of a left femur divided by vertical section.

The bone is in a condition of acute inflammation. The periosteum has been stripped from much of the lower third of the shaft, and on the inner side the bone is at one place white and dead. The medullary cavity is filled with a purulent, gelatinous material which has replaced the marrow. The articular cartilage of the condyles is slightly eroded in places.

Museum of St. Bartholomew's Hospital, A.38

CLINICAL HISTORY.—The patient was a man, aged 43, who died four days after admission to hospital. He gave an indefinite history of an injury received four weeks before admission. There was a large abscess in the popliteal space which was opened and drained. The infecting agent was *Staphylococcus pyogenes aureus*.

AUTOPSY.—Pus was found between the muscles of the lower third of the thigh and in the knee-joint, the synovial membrane of which was much injected and swollen. The lungs were congested and œdematous. The spleen was large and soft. All the other organs were normal.

S.A.SEWELL
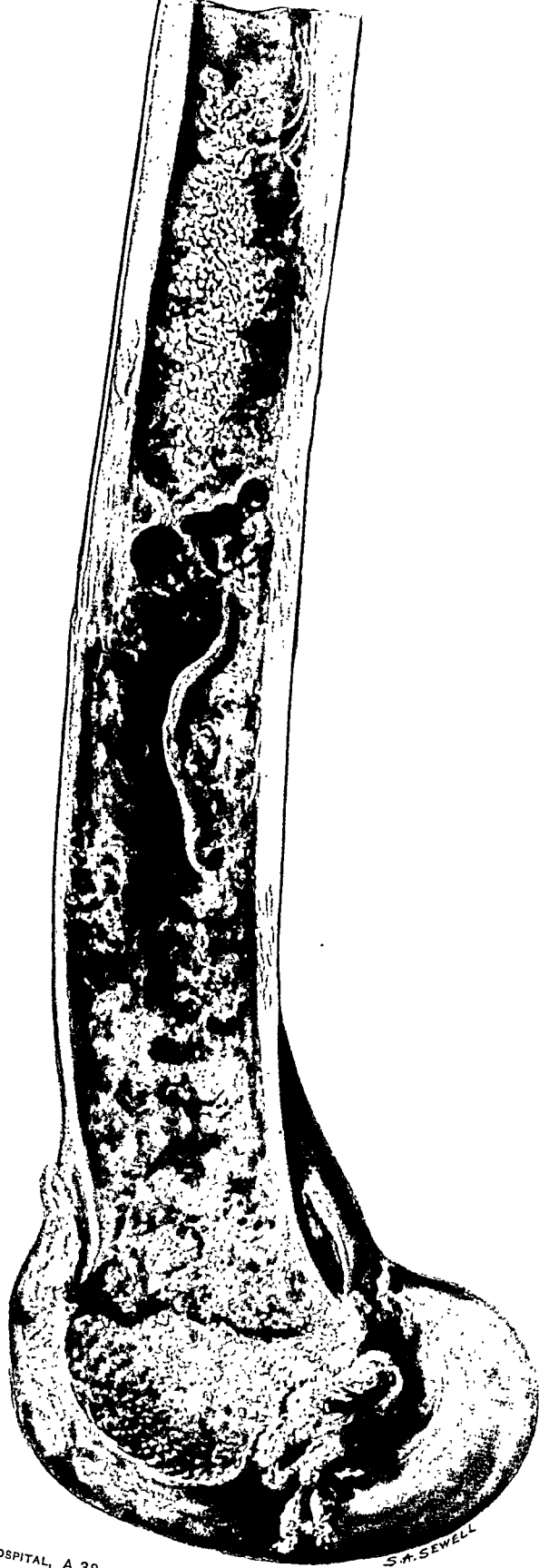
ACUTE OSTEOMYELITIS.

The left femur of an infant divided by coronal section.

The whole length of the bone from one cartilaginous extremity to the other is in a condition of acute inflammation, the inflammatory changes being confined to the interior of the shaft except for a narrow strip, about one and a half inches long, where the periosteum has been raised from the cortex.

Museum of University College Hospital, PM/209/28

CLINICAL [HISTORY.—The patient was a female infant, aged 3 months, who was admitted to hospital in a moribund condition and died almost immediately. No operation was performed.

453

ACUTE OSTEOMYELITIS.

The upper half of a right humerus, mounted upside down.

The upper epiphysis is separated from the diaphysis. The whole of the upper third of the shaft is completely denuded of periosteum and the bone is rough and necrotic. The epiphysial surfaces are covered with pus. Only a small portion of cartilage remains on the head of the bone. The rest of its surface is rough, and, in the recent state, was covered with pus.

Museum of St. Bartholomew's Hospital, A.75

CLINICAL HISTORY.—The patient was a youth, aged 18, who injured his right index finger a fortnight before death. On admission to hospital the index finger was in a septic condition and the upper arm was red and œdematous. An incision was made through the deltoid, and pus was let out from beneath the periosteum. The infective agent was *Staphylococcus pyogenes aureus*. He died a week later.

AUTOPSY.—The shoulder-joint contained pus, which had tracked down as far as the elbow-joint. The latter was not infected. There were pyæmic abscesses between the tendons on the anterior aspect of the left ankle-joint and in the lungs. Bronchopneumonia.

455

ACUTE OSTEOMYELITIS.

The lower part of a left femur in sagittal section.

The periosteum has been stripped by pus behind and to the outer side of the shaft down to the epiphysial line. The medulla and cancellous tissue of the lower end of the diaphysis are full of pus. The epiphysial cartilage is intact.

Museum of University College Hospital, 48.A.3

CLINICAL HISTORY.—The patient was admitted to hospital in a condition of pyæmia, and died shortly afterwards.

AUTOPSY.—Suppurative pericarditis, pleurisy, and multiple abscesses of the lungs.

457
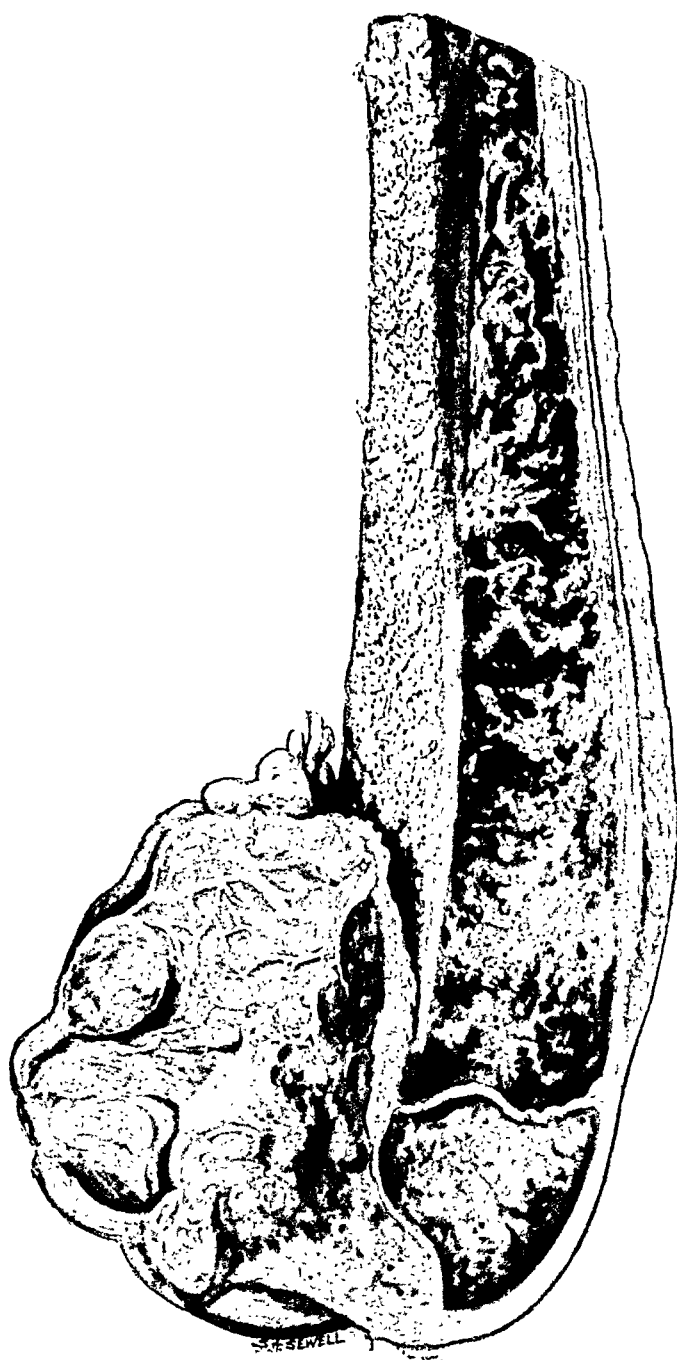
ACUTE OSTEOMYELITIS.

The lower part of the left femur of a child, with some of the soft parts covering it. The bone has been divided by coronal section.

Complete separation of the epiphysis has resulted from suppuration occurring between the epiphysial cartilage and the diaphysis. The suppuration has extended upwards beneath the periosteum, separating that membrane from the bone except along a narrow strip on the anterior surface of the shaft. Small fragments only of the epiphysial cartilage remain, and the adjacent cancellous tissue of the shaft is ulcerated, most extensively in its inner part, where irregular spaces in it are occupied by granulation tissue.

Just above the patellar surface of the femur is the mouth of a sinus which leads from the interval between epiphysis and shaft into the knee-joint. The synovial membrane around its mouth is covered with granulation tissue, and a portion of the articular cartilage has been eroded.

Museum of University College Hospital, 48.A.2

CLINICAL HISTORY.—The patient was a girl, aged 9 years, who complained of pain and swelling of the left thigh three days before admission to hospital. She had had a fall two days before the onset of the pain. On the eighth day an abscess was opened above the internal condyle, and the lower part of the shaft of the femur was felt to be bare. Subsequently, pyæmic abscesses were opened in various parts of the body, and on the nineteenth day the lower epiphysis was found to be separated from the shaft. The leg was amputated in the lower third of the thigh, and the patient left the hospital three months after admission with a sinus in the stump.
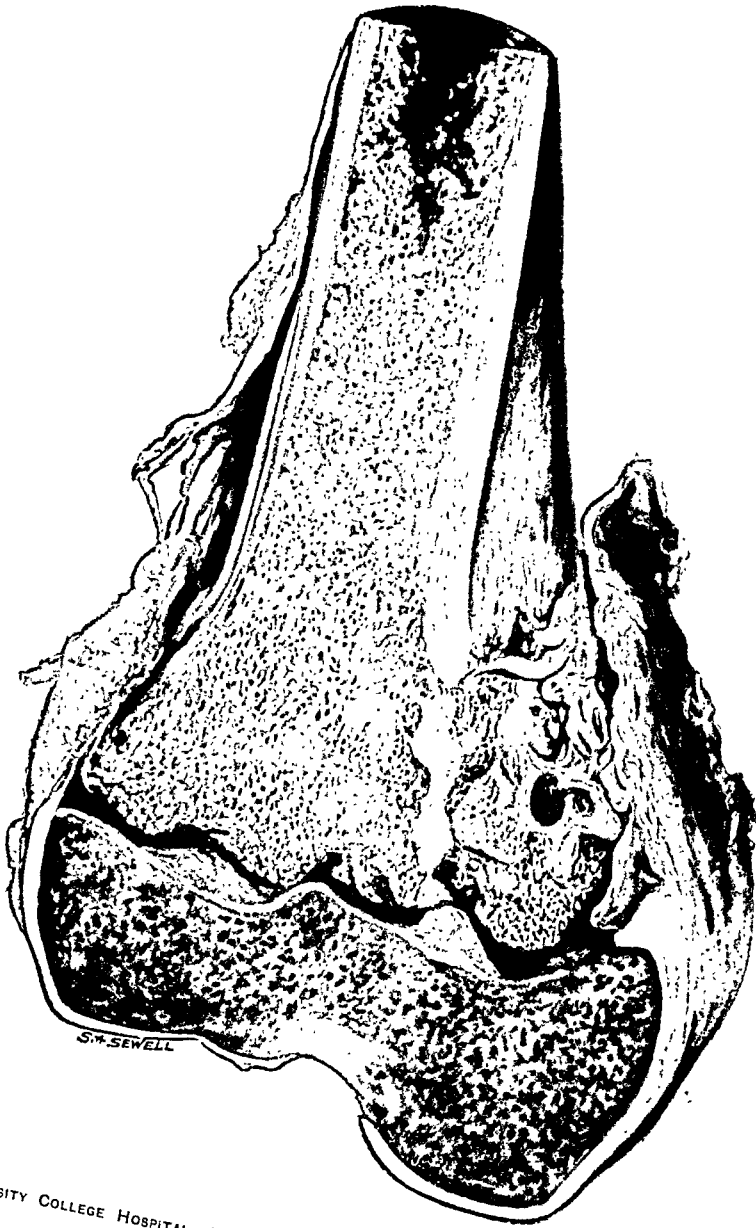
S.A.SEWELL

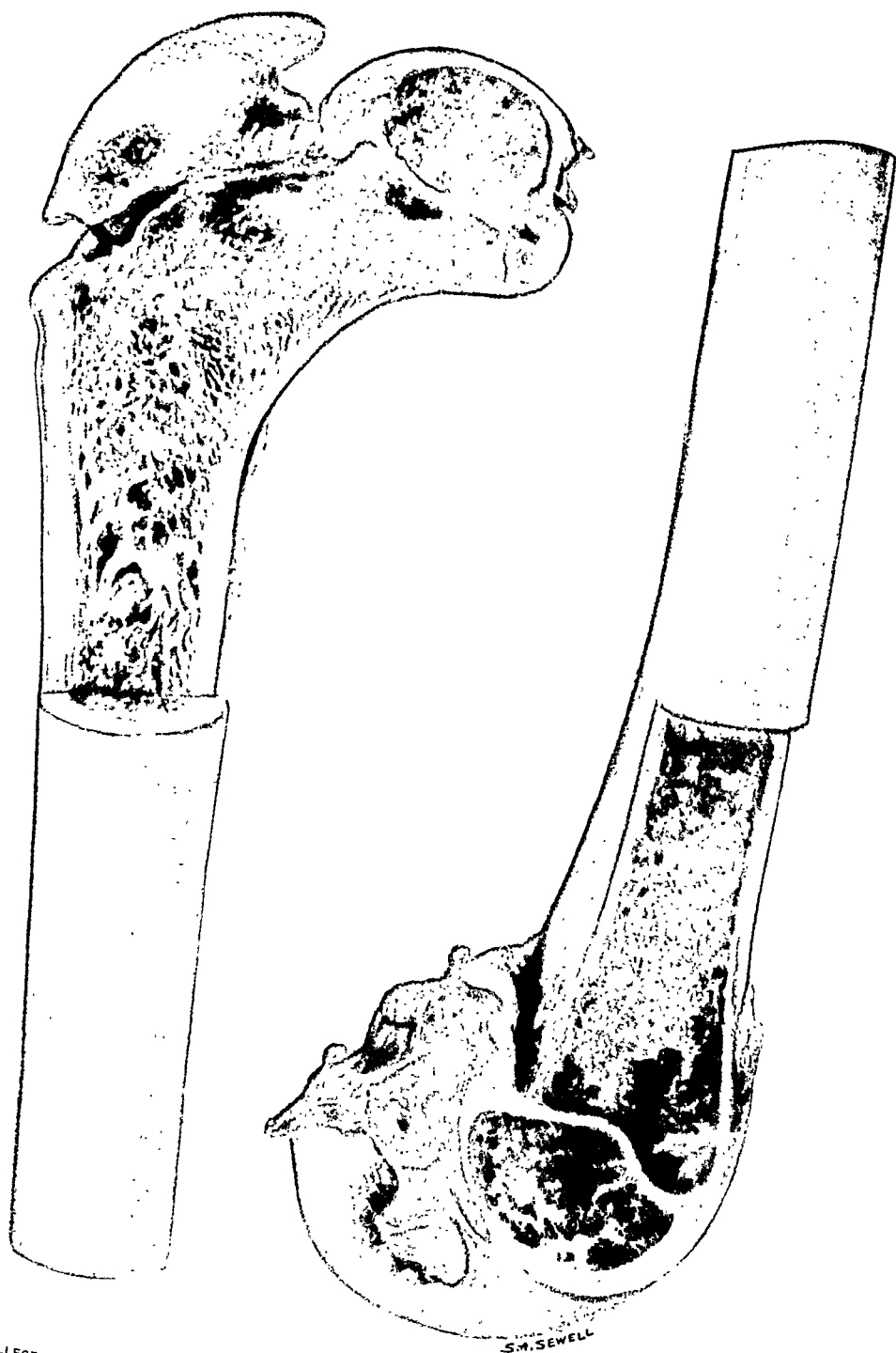# ACUTE OSTEOMYELITIS.

Part of the right femur of a child.

The shaft of the femur is acutely inflamed, and areas of pus and hæmorrhage are scattered throughout the medulla. The periosteum is separated from the bone except at the epiphysial line and at the linea aspera. The infection has resulted in separation of the great trochanter at its epiphysial line.

Museum of the College of Medicine, University of Durham, Newcastle-upon-Tyne, C.2543

CLINICAL HISTORY.—The patient was a boy, aged 6 years, who was admitted to hospital complaining of severe pain in the right groin of three days' duration. The pain radiated from the hip down to the knee.

On examination the temperature was 103–104°, the pulse 132, and the tongue was dry and brown. The right hip was hot and swollen and its movements were limited and painful. There was no tenderness or œdema. A skiagram showed irregularity of the acetabulum and of the head of the femur. Despite drainage the fever continued, and the patient died a fortnight later.

AUTOPSY.—Pyæmia due to staphylococcal infection.

461

ACUTE OSTEOMYELITIS.

The lower end of a tibia in longitudinal section, mounted upside down.

There is extensive suppuration in the interior of the shaft, both above and below the epiphysial cartilage, which is partly destroyed and is perforated. During life, the periosteum was separated from the shaft by a layer of pus. Staphylococci were isolated from the pus.

Museum of the College of Medicine, University of Durham, Newcastle-upon-Tyne, 600/87

CLINICAL HISTORY.—The patient was a girl, aged 13 years, who was admitted to hospital with a painful swelling of the leg of two days' duration. Multiple abscesses appeared upon the left ankle, limbs, and neck. The leg was incised and a considerable amount of pus was evacuated. Death occurred two days later.
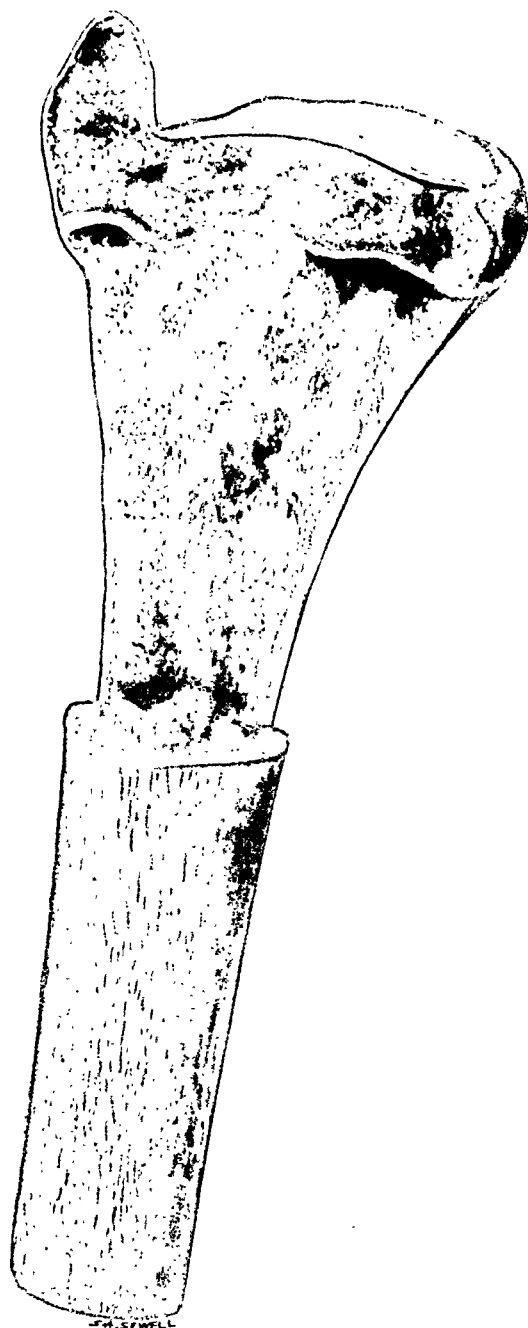
463

OSTEOMYELITIS : CENTRAL ABSCESS.

S.A SEWELL

Part of the shaft of a tibia, divided by longitudinal section.

There is an abscess in the medullary cavity, and around it the compact bone of the shaft is thickened by the addition of new bone laid down by the periosteum.

Museum of the University of Sheffield, A.VI.20

CLINICAL HISTORY.—The patient was a man, aged 19, who suffered from a painful enlargement of the lower part of the shaft of the tibia. The portion of bone shown was removed by subperiosteal resection.

CHRONIC OSTEOMYELITIS.

The right tibia of a child seen from behind.

The periosteum has been removed to expose the new bone which has been formed beneath it as a result of the stimulus provided by inflammation. The new bone is heaped up in the intervals between the numerous vascular channels. The infection began at the lower end of the diaphysis, and its spread upwards is reflected in the greater quantity of new bone which has been formed at the lower end.

Museum of University College Hospital,
PM/21/28

CLINICAL HISTORY.—The patient was a girl, aged 11 years, who had had pain and swelling of the right ankle for five days before admission to hospital. Immediate operation. The ankle-joint contained pus, from which *Staphylococcus aureus* was grown, and the whole length of the shaft of the tibia was opened along the inner side. The patient died 3½ months later after removal of a sequestrum.

AUTOPSY.—All organs pale. Purulent bronchitis, both lungs.

NO. 20—SUPPLEMENT

OSTEOMYELITIS : SUBPERIOSTEAL ABSCESS.

The right femur of an infant drawn from the surface and in transverse section.

The bone is enlarged from a point just above the condyles to beyond the middle of the shaft. The section shows the original shaft lying in the centre of a cavity with bony walls, the space between the shaft and the inner surface of the wall of this cavity measuring five-eighths of an inch. A few irregular fibrous bands bridge the space, which contained pus when opened. A rod has been placed in a small opening on the inner side of the bone, where an incision was made seventeen days before death.

The opposite femur was in a similar condition, but at an earlier stage.

Museum of St. Bartholomew's Hospital, A.81

CLINICAL HISTORY.—The patient was a male infant, aged 1 year, who had been ill with swelling of both thighs and legs for a few days before admission to hospital. He had never been strong, and had had bronchitis. One week after admission he had a temperature of 100° and was restless and in pain. The legs were swollen and œdematous. The lower part of both thighs was *greatly swollen, especially on the right side.* There was no effusion into the joints. Pus was evacuated by an incision on the inner side of the right femur. The legs were splinted and gave little further trouble. He died of bronchitis and laryngitis three weeks after admission.
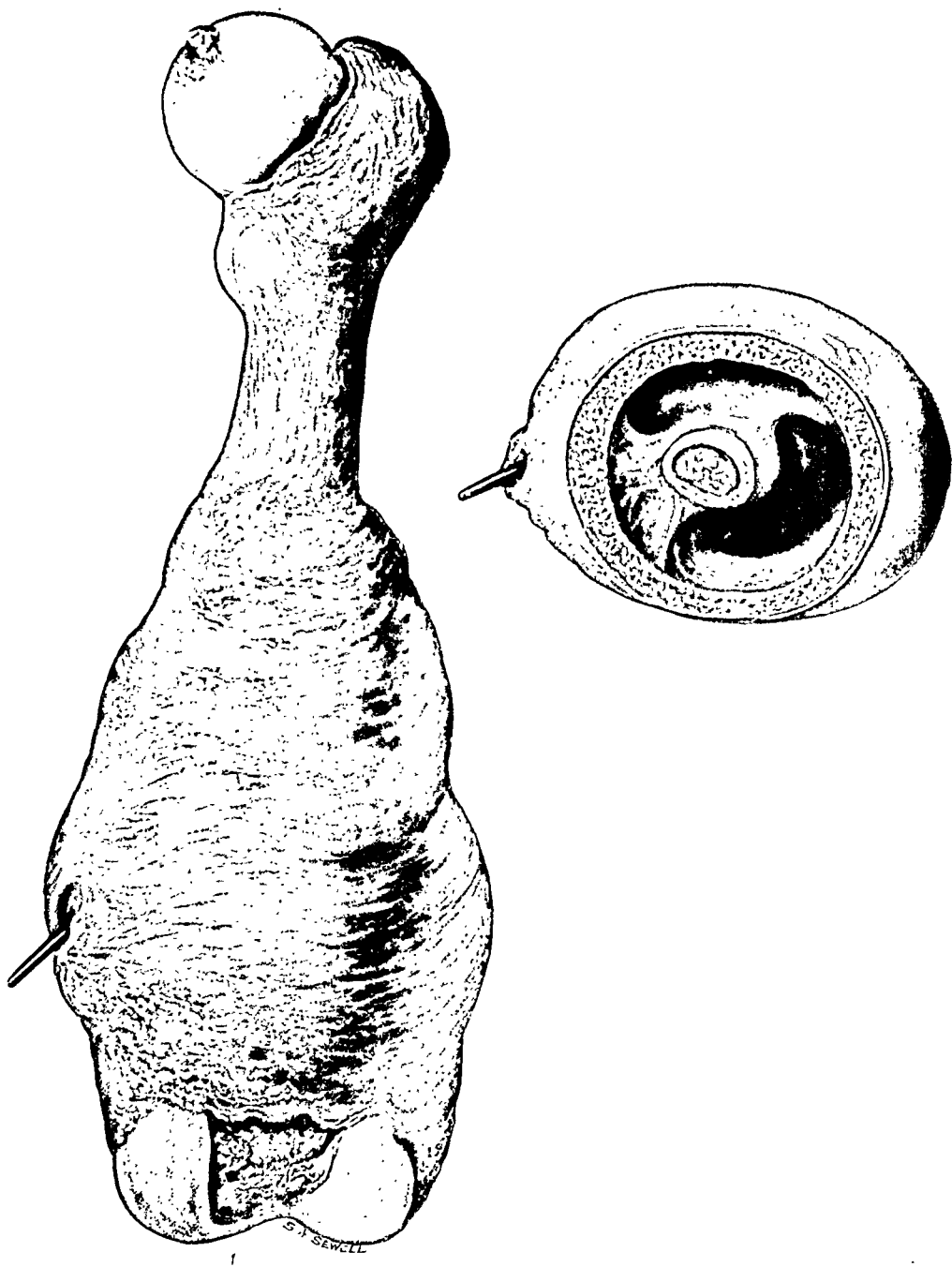
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No. 20—SUPPLEMENT

U 1

CHRONIC OSTEOMYELITIS.

The lower end of a right femur divided by coronal section.

An irregular cavity, three inches in length, lined by granulation tissue, opens on the inner side of the bone. The shaft is thickened by chronic inflammation.

Museum of St. Thomas's Hospital, 190.A

CLINICAL HISTORY.—-The patient was a man, aged 50, who had been kicked by a horse on the right thigh eighteen years before admission to hospital. The injury was followed a few days later by suppuration, and an abscess was opened. It discharged for two years, but healed after sequestrectomy. A later blow on the same spot led to recurrence of suppuration, which persisted up to the date of admission. The urine contained a quantity of albumin. The leg was removed by amputation.

S.T.SEWELL

Atlas of Pathological Anatomy
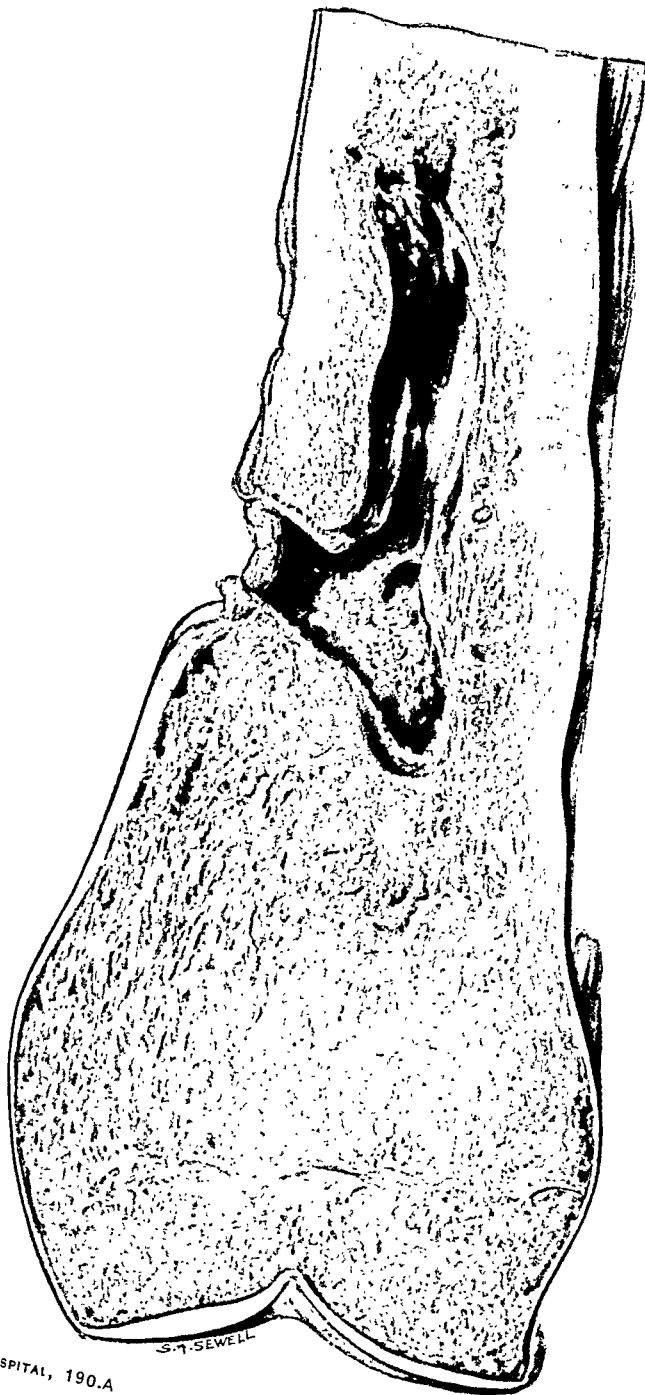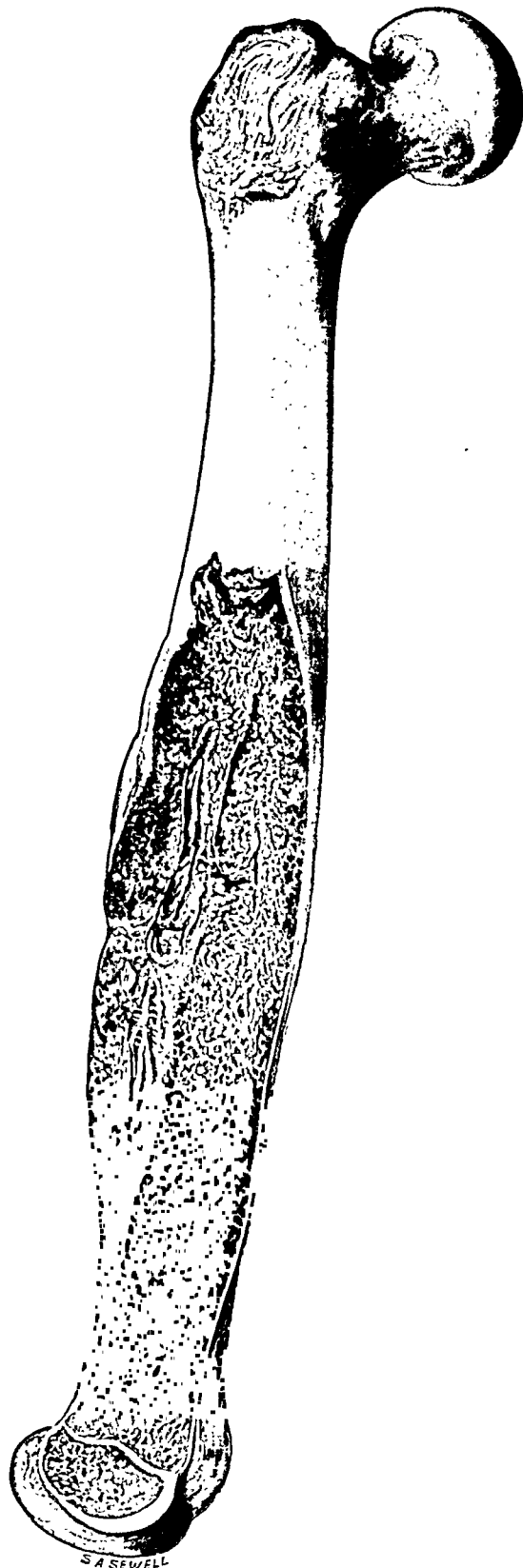
CHRONIC OSTEOMYELITIS.

The right femur of a child. The lower two-thirds of the medullary cavity has been exposed by longitudinal section.

The greater part of the shaft is thickened in a fusiform manner by the deposition of new subperiosteal bone. On the posterior surface of the original compact bone of the shaft is a narrow sequestrum which has been enclosed by the newly formed bone.

Museum of University College Hospital, 54 A.5

CLINICAL HISTORY.—The patient was a boy, aged 8 years, who had had an operation for acute necrosis of the right femur. The scar had healed.

AUTOPSY.—There was a small, encapsuled abscess beneath the scar. There were two abscesses in the cerebrum, and pus in both ventricles and meninges. The right knee-joint was normal.

S A SEWELL

CHRONIC OSTEOMYELITIS.

· (EXTENSION FROM NEIGHBOURING JOINT.)

One half of a left knee divided by sagittal section.

The compact bone of the femur is thickened and the medullary cavity and cancellous tissue contain numerous cavities. There is bony ankylosis between femur and tibia, and between femur and patella. The cutaneous surface is marked by scars of operations and by healed and open sinuses.

Museum of St. Thomas's Hospital, 195

CLINICAL HISTORY.—The patient was a man who cut his left knee with a chopper fourteen years before the date of amputation. The injury was followed by acute septic arthritis. The joint was drained, and healed three months later. Since that time there had been recurrent attacks of pain and swelling which were followed by the appearance of sinuses.

On examination, the knee was ankylosed at an angle of 170°; the lower half of the femur was thickened and there were many sinuses. There was no evidence of amyloid disease.

X-RAY.—Bony ankylosis of knee. Chronic osteomyelitis of lower half of femur and head of tibia.

Amputation was followed by uneventful recovery. The micro-organism present was *Staphylococcus aureus*.

473

CHRONIC OSTEOMYELITIS IN AMPUTATION STUMP.

The upper third of a right femur from an amputation stump.

The shaft has undergone necrosis, with the exception of the superficial layer of its wall, and lies ensheathed within a case of closely cancellated bone more than one centimetre thick. The lower end of the sequestrum includes the entire thickness of the shaft. A short distance below the great trochanter the new bone is perforated by three cloacæ. On the inner aspect a fourth cloaca passes up in the lower part of the neck of the femur. It is possible that this opening communicated with the hip-joint, for the head of the bone is superficially ulcerated.

Museum of University College Hospital, 46.A.2

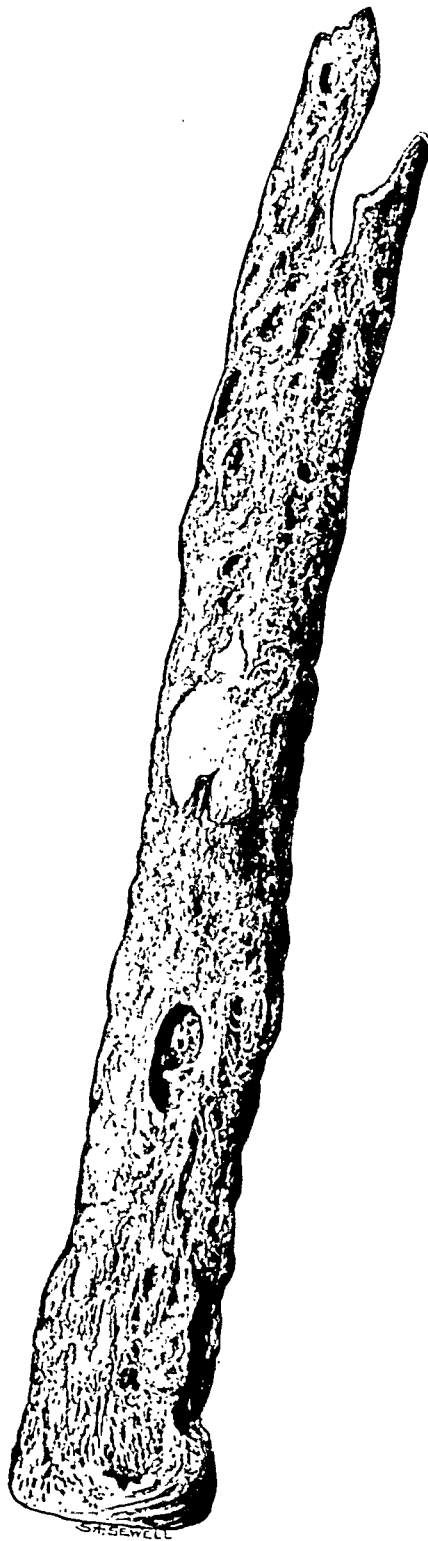No clinical history.

S. T. SEWELL

Atlas of Pathological Anatomy

AMPUTATION SEQUESTRUM.

A sequestrum, 7½ inches long, from the shaft of a femur.

At its lower end the sequestrum includes the whole thickness of the bone, but in the greater part of its length the outer surface is irregularly pitted. The upper border, along which the sequestrum has been detached, is jagged.

Hunterian Museum, R.C.S., 733.1
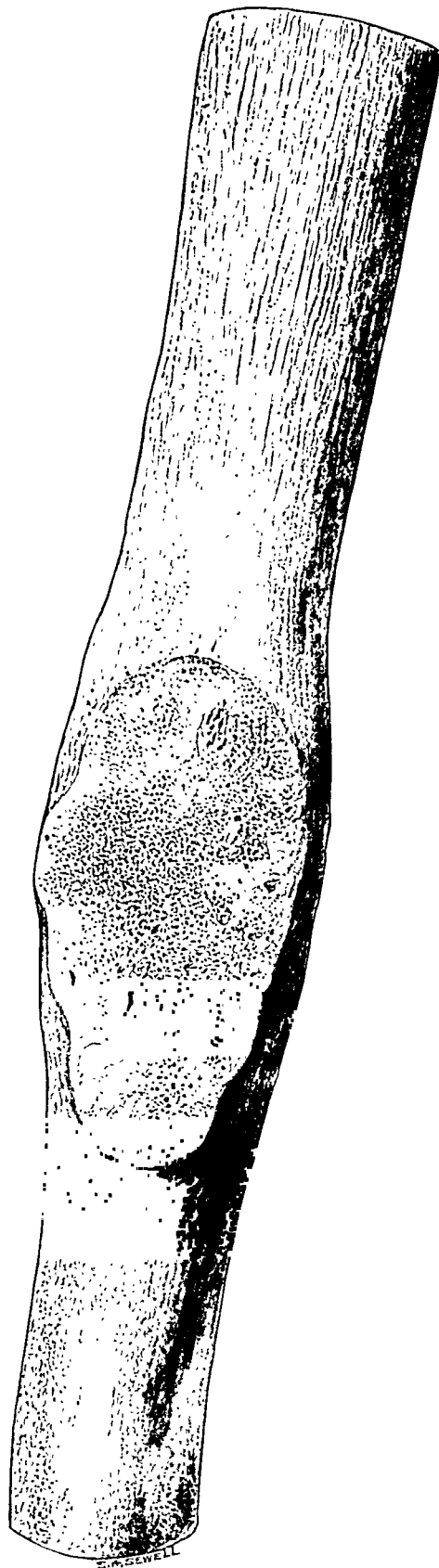*[Hunterian Specimen]*

S.A.SEWELL

477

CHRONIC PERIOSTITIS.

Part of the shaft of a tibia.

On the subcutaneous surface is an oval, elevated area of new bone, the uniform flatness and sharp edge of which show that it has been produced in the base of an ulcer of the overlying soft parts.

Hunterian Museum, R.C.S., 699.1
[Hunterian Specimen]

479

ACUTE OSTEOMYELITIS.

(EXTENSION FROM SOFT PARTS.)

The lower two cervical and upper eight dorsal vertebræ divided by sagittal section.

From the 6th cervical vertebra downwards the space between the theca and the posterior surface of the bodies is filled with sloughs and inflammatory exudate. The spaces between the vertebræ contain the necrotic remains of intervertebral discs, and, at two points, end in cavities in front of the column. The bodies of the vertebræ show varying degrees of disorganization, from a grey mottling by inflammatory exudate into their cancellous spaces up to complete necrosis.

The spinal cord is compressed against the neural arches, but there is no meningitis.

Museum of University College Hospital, 4.R.6

CLINICAL HISTORY.—The patient was a married barmaid, aged 42. Eighteen months before admission to hospital she ate a piece of fish, swallowed a bone, and felt a sudden pain in the back of the neck. The pain remained with her and was made worse by swallowing. Five weeks before admission both hands became weak.

On examination there was rigidity and tenderness over the affected region of the spine, where a local swelling developed in the later stages of the disease. There was an irregular fever up to 103°.

There was a carcinoma of the cervix uteri as well as the spinal infection. The patient died four months after admission.

AUTOPSY.—A perforation of the œsophagus led into a cavity between the 7th cervical and the 1st dorsal vertebræ. The micro-organisms found in the pus were the spirochætes and fusiform bacilli characteristic of Vincent's angina. The ureters were obstructed by growth.

E.H.SEWELL
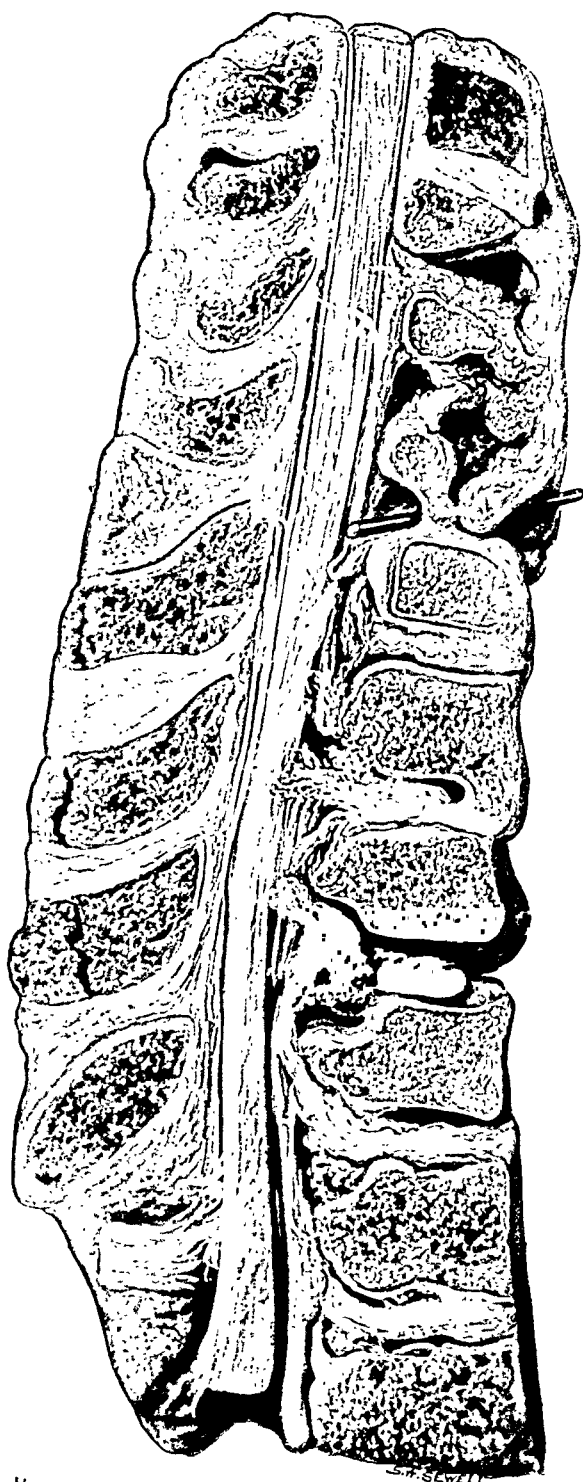
# CHRONIC OSTEOMYELITIS.

(Epithelioma Arising in Sinus.)

The lower end of a thigh divided by vertical section.

The femur is thickened and sclerosed by inflammation associated with necrosis. A squamous carcinoma has grown in connection with the sinus. It projects but little from the cutaneous edge, where it has a warty surface, but extends deeply into both soft parts and bone. At the back of the specimen is a second growth of the same kind in another sinus.

Museum of St. Thomas's Hospital, 190.B

MICROSCOPIC STRUCTURE.—Squamous-cell carcinoma. Inguinal glands free from growth.

CLINICAL HISTORY.—The patient was a man, aged 49, who had had acute necrosis of the femur thirty-three years before admission to hospital. There were four sinuses leading down to the popliteal surface of the bone. The limb was removed by amputation.

483
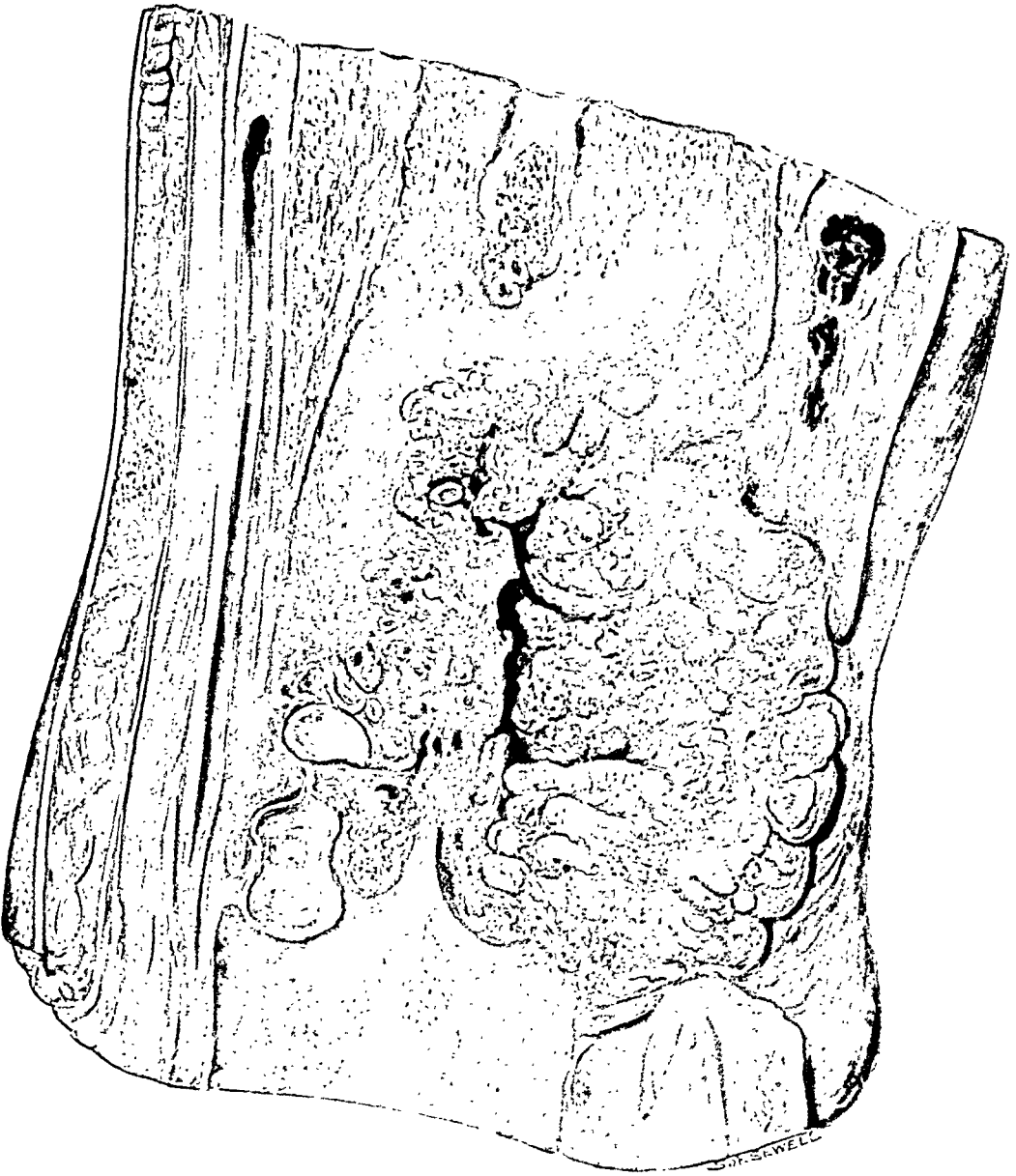
End of Volume 1 of the

ATLAS OF PATHOLOGICAL ANATOMY

Comprising Fasciculi I–V.

I. TUMOURS OF BONE

II. DISEASES OF THE STOMACH

III. DISEASES OF THE BREAST

IV. DISEASES OF THE KIDNEY

V. DISEASES OF THE GALL-BLADDER AND
BILE-DUCTS. INFLAMMATION OF BONE